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Supplementary Information for

Understanding the Role of Individual Units In a Deep Neural Network

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Supplementary text
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Captions for Movies S1 to S3
References for SI reference citations

Other supplementary materials for this manuscript include the following:

Movies S1 to S3

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Supporting Information Text

A. Emergent concepts across layers and networks. We compare emergent concepts that appear across more layers and architecture variations for scene classification CNNs, and we compare emergent object concepts across layers in the GAN generators trained with different scene training set.

Figure S1 compares the emergence of units that match semantic concepts in classifiers trained with different architectures (VGG-16 (1), AlexNet (2), and ResNet (3)) and in generators trained on different data sets (LSUN kitchens, bedrooms, and outdoor church scenes (4)). A similar pattern of detected concepts can be seen across these variations: in the classifiers, the largest number of detected objects appears in the final convolutional layer, while in the generators, units that match most objects appear in the middle layers of the network.

Figure S2 details the concepts that are matched at every convolutional layer of VGG-16 and AlexNet.

Figure S3 characterizes texture-sensitivity and shape-sensitivity of units by observing changes in behavior each unit on a stylized images in which textures have been randomized. We construct a stylized-places data set using the stylization method described in (5). Then $IoU(s, u)$ denotes the IoU when comparing the 99% activation of unit u on the original Places images compared the behavior of the same unit on the stylized-Places images (indicated as s). Low $IoU(s, u)$ indicates texture-sensitivity and high $IoU(s, u)$ indicates shape-sensitivity. Figure S3a-c show the distribution of texture-sensitive versus shape-sensitive units across layers of VGG-16. Figure S3d visualizes texture-sensitive units which activate on very different parts of images when the style is altered, and Figure S3e visualizes shape-sensitive units which activate in many of the same parts of images when the style is altered.

B. Characteristics of the most- and least- important units. We further explore the role of class-important units within a classifier, asking how much single-class accuracy can be improved by dropping unimportant units; go what degree units that are important to multiple scene classes match lower-level semantic visual concepts closely; and whether important units are positive correlated or negatively correlated with their associated classes.

Figure S4a-b show the increase in single-class classification accuracy, by eliminating the 256 `conv5_3` units that are least important to the class. Eliminating these units improves the network's ability to classify specific class, increasing accuracy from 76.6% on average to 92.1% on average. This effect has been observed across all classes.

Figure S4c-f explore the relationship between the number of scene classes for which a unit is important and the mean IoU of the unit. Units that are important to many scene classes have higher IoUs (i.e., they more closely match a semantic visual concept such as an object or an object part) when compared to units that are important to none or few scenes. In these plots, the relationship is shown to hold, regardless if a unit is counted as important to a class by when it is among the top-2 important, top-3, top-4, or top-5.

Figure S4g, reveals a relationship between the mean class importance of a unit and its IoU. The mean class importance of a unit is the reduction in single-class (binary classification) accuracy when the single unit is removed from the network, averaged over all the output classes. Note that mean class importance is different from the reduction in multiclass all-class classification accuracy when a unit is removed: Units that are important to several classes will tend to have higher mean class importance, but units that contribute to multiclass classification accuracy without being important to any class will tend to have lower mean class importance. Figure S4g divides the 512 units into 16 buckets of 32 units, grouped by mean class importance, and shows that the most important units tend to have the highest mean IoU, i.e., they most closely match semantic visual concepts.

Figure S4h examines the correlation between each unit and each class, comparing units that are important to each class with other units. The plot includes 512 × 365 points, one for the relationship between each of 512 units and 365 output classes. The importance is plotted as the reduction in single-class accuracy when the unit is removed from the network, and the correlation relates the peak activation of the unit to the softmax prediction score of the class. The top-4 most-important units for each class are colored blue; the remaining relationships are orange. The highest density of the plot is enclosed in the red box: 58.9% of unit-class correlations are negative. However, almost all correlations for top-4 units for each class is a positive correlation. This would not necessarily need to be the case: for example, the network could in principal encode a rule such as "grass never appears inside a conference room" by giving importance to a grass-detecting unit that negatively correlates to the conference room class. However, such negative signals do not seem to be important: all the important relationships between `conv5_3` units and output classes have positive correlations.

Figure S5 shows several examples in which different overlapping subsets of units are important to different output classes. In each of the examples shown, there are three units that are each within the top-4 most important units for two out of three of the three output classes, but not the third. For example: a 'house' detector unit is important to both the 'boathouse' and 'farm' class, but a 'water' unit is only important to 'boathouse' and a 'grass' unit is only important to 'farm'; in contrast, 'water' and 'grass' units are both important to the 'pond' scene class, whereas the 'house' unit is not important to 'pond'. These varying combinations illustrate the effects seen numerically in Figure S4c-f: units that are important to multiple different output classes tend to align with meaningful concepts that can be used to make distinctions that generalize beyond one class.

C. Full visualization of all the units in a layer. We expand upon the selected visualizations of units shown in the main paper by providing the same visualization for all the units in the analyzed classifier and generator layers.

Figure S6 through Figure S12 show visualizations of all 512 units of `conv5_3` of the VGG-16 tested in the main paper. Each unit is illustrated with the top-5 activating images from the validation set, highlighting the regions where the activations exceed the 1% quantile. For each unit, the best-matching concept with the highest $\mathrm{IoU}_{u,c}$ is shown, along with all output scene classes for which the unit is among the top four important units for the class. Units are listed in order from the highest IoU to the lowest.

Figure S13 through Figure S18 show visualizations of all 512 units of `layer5` of the Progressive GAN kitchen image generator (6) tested in the main paper. Each unit is illustrated with the top-5 activating images from a set of 10,000 generated images, highlighting regions where the activations exceed the 1% quantile. For each unit, the best-matching concept with the highest $\mathrm{IoU}_{u,c}$ is shown.

D. Video demonstration of GAN image manipulation. Our provided image-editing movies show direct manipulation of units of a generator. In Movie S1, trees are removed from scenes, revealing details behind the trees. In Movie S2, doors are added to scenes, showing context-sensitivity. In Movie S3, a variety of other edits are done, showing creative effects that can be achieved by allowing a user to manipulate units directly.

References

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2. A Krizhevsky, I Sutskever, GE Hinton, Imagenet classification with deep convolutional neural networks in *NeurIPS.* pp. 1097–1105 (2012).
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4. F Yu, et al., Lsun: Construction of a large-scale image dataset using deep learning with humans in the loop. *arXiv preprint arXiv:1506.03365* (2015).
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6. T Karras, T Aila, S Laine, J Lehtinen, Progressive growing of gans for improved quality, stability, and variation in *ICLR.* (2018).

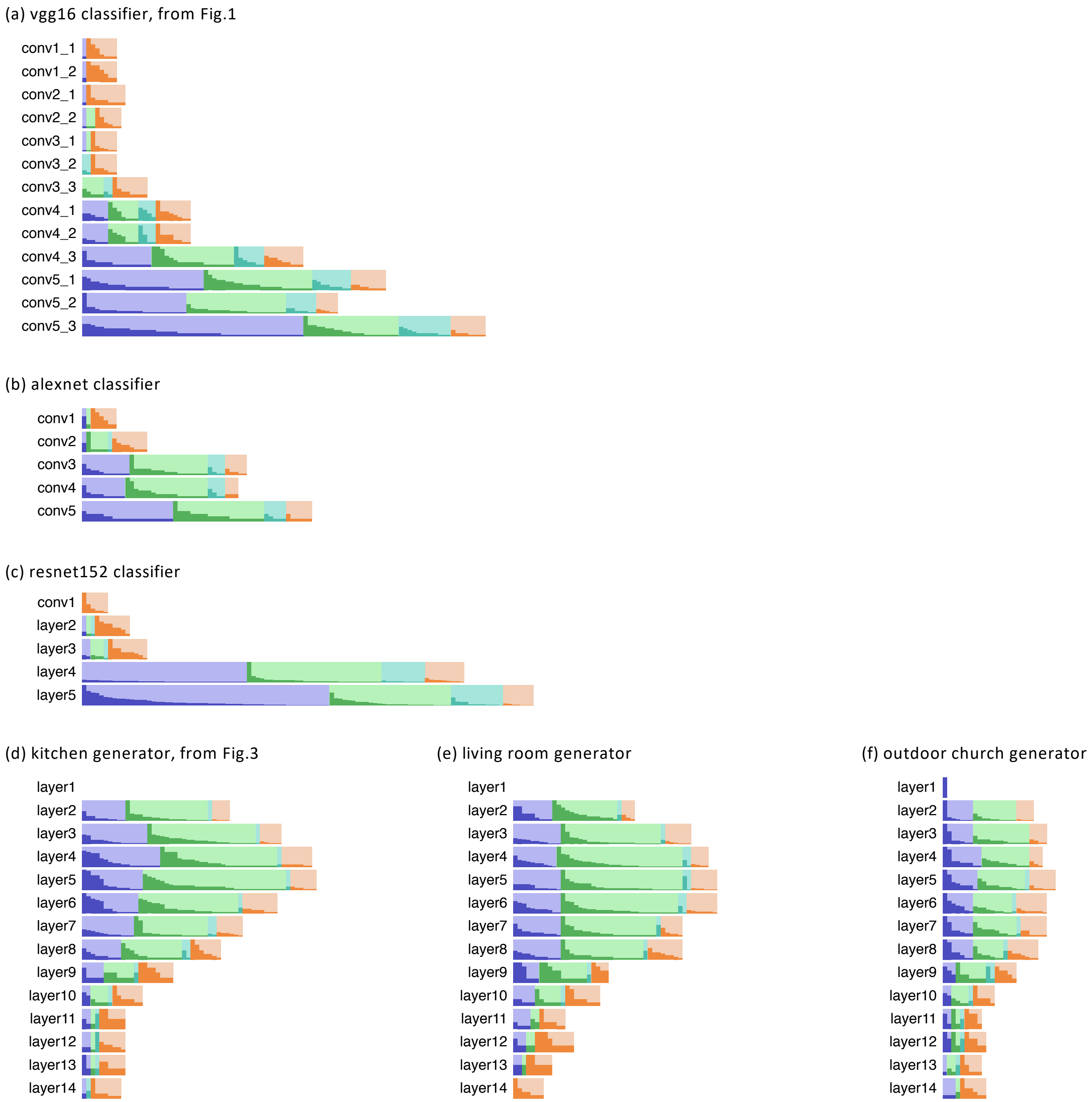

Fig. S1. Comparing layers across models. (a) For reference, the VGG16 classifier (1) from the main paper Fig.1. (b) An AlexNet classifier (2) trained on the same scene classification problem. A similar structure emerges, but fewer object classes. (c) A ResNet152 classifier (3) trained on the same problem. The structure is similar again. Each layer of ResNet is a residual block consisting of many convolutions: in ResNet152, layer4 contains 105 convolutions that compute residuals that are added together. Only non-residual layer representations are shown. (f) For reference, the progressive GAN model trained to generate kitchen images, from the main paper Fig.3. (g) A progressive GAN (6) trained to generate living room images shows a similar structure. (h) A progressive GAN trained to generate outdoor church images represents a smaller number of identified classes, but the same overall structure, with object-specific units peaking at the middle layers.

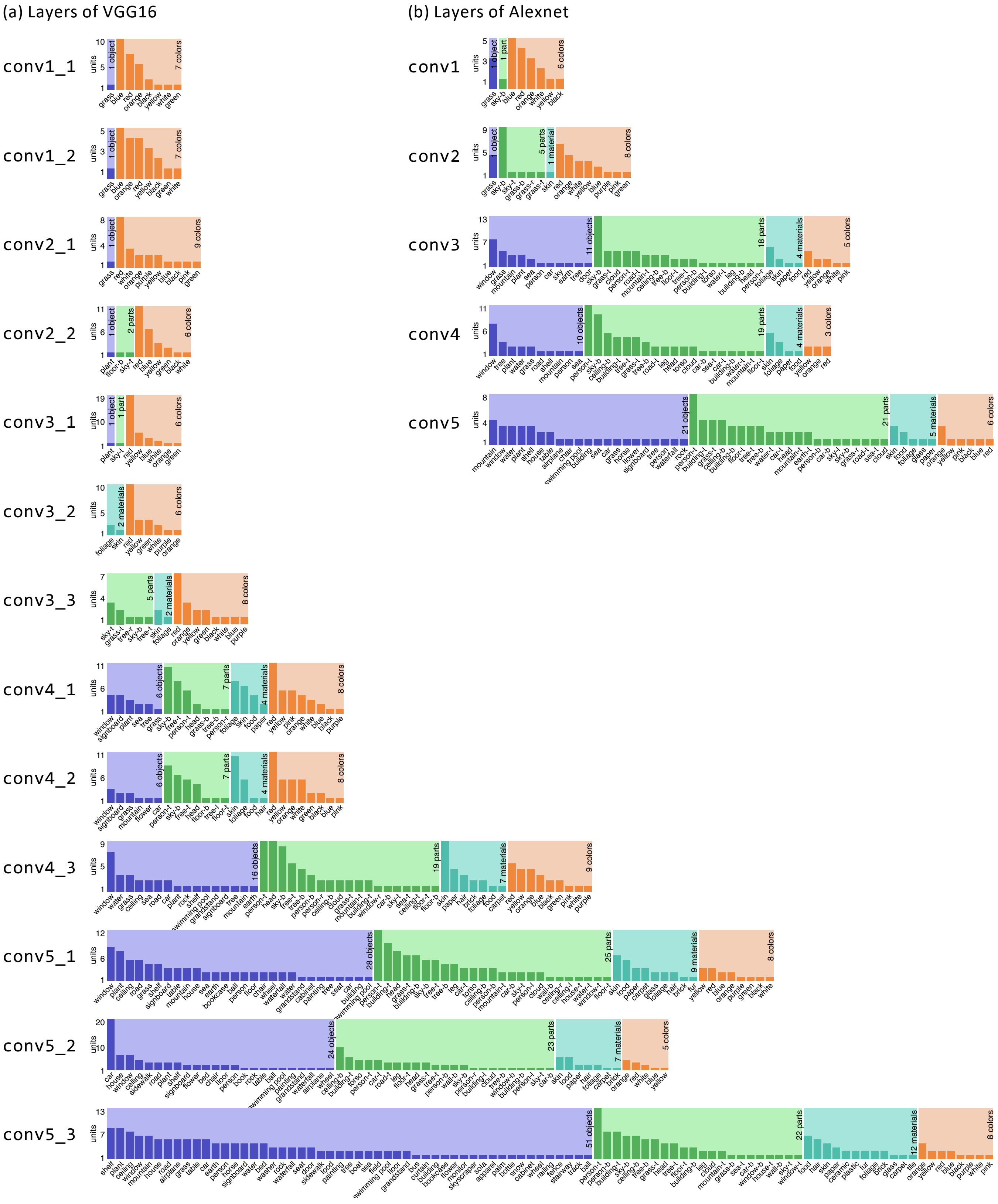

Fig. S2. (a) Comparing visual concepts detected across layers of VGG-16. All units that match segmented concepts are shown except those with $\mathrm{IoU}_{u,c} < 4\%$. The `conv5_3` layer is the same as shown in Fig.1 of the main paper. (b) The analysis of the five convolutional layers of AlexNet trained on the same scene classification task. Some features, such as a large number of emergent 'person top' detectors, are common between the architectures.

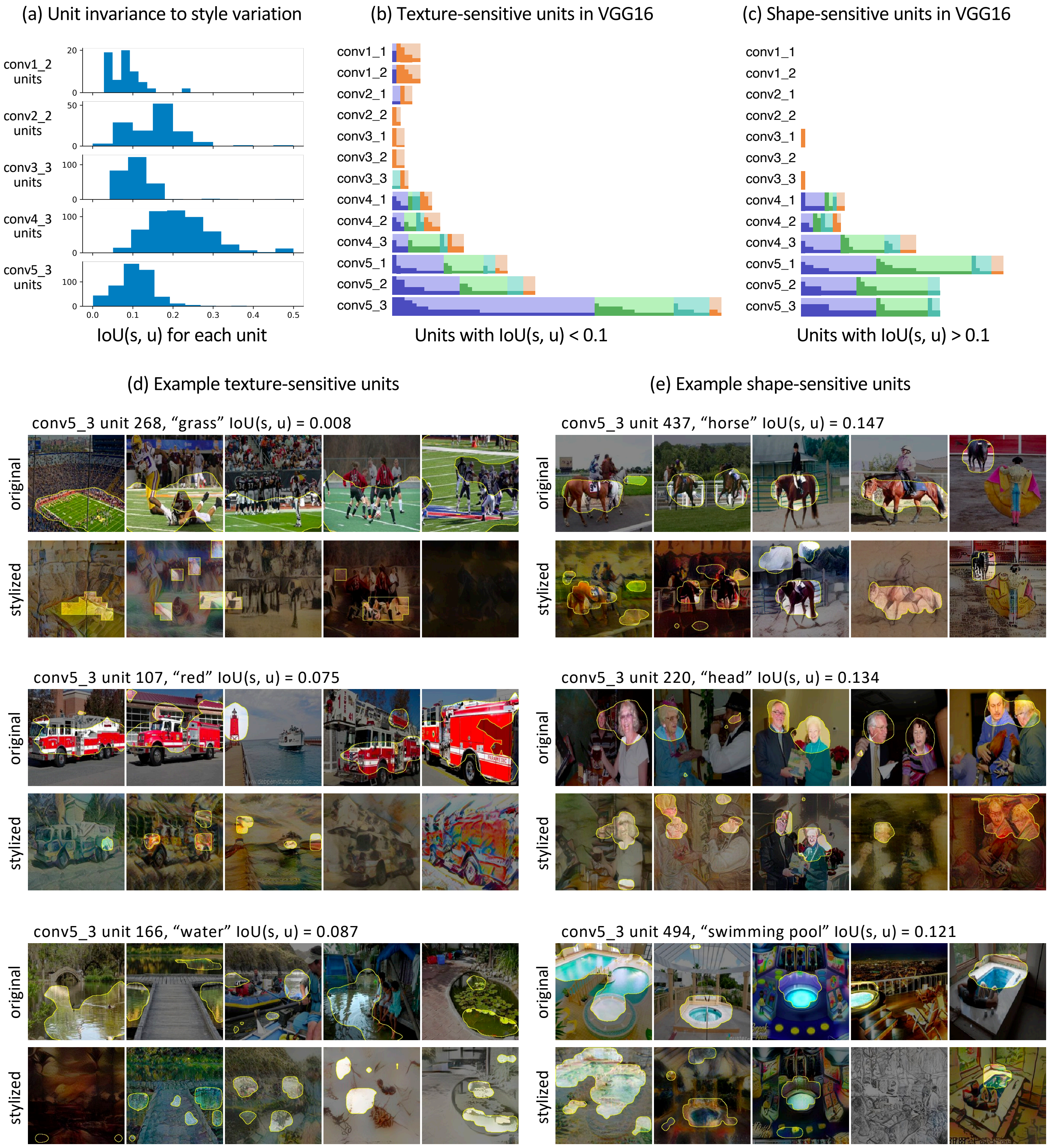

Fig. S3. Characterizing texture-sensitivity and shape-sensitivity of units by observing changes in behavior each unit on a stylized images in which textures have been randomized. (a) The distribution of $IoU(s, u)$ on different layers of VGG-16 trained on places. All layers show many texture-sensitive units including the final feature layer, but some shape-sensitive units emerge at later layers such as `conv4_3`. (b) Texture-sensitive units for every layer, plotted as in Figure S2; only units with $IoU(s, u) < 0.1$ are shown. (c) Shape-sensitive units plotted, limiting to units with $IoU(s, u) > 0.1$. (d) Visualization of texture-sensitive units: when the style is changed, they activate on different portions of the images. (e) Visualization of shape-sensitive units: even when the style is changed, these activate on many similar regions within images.

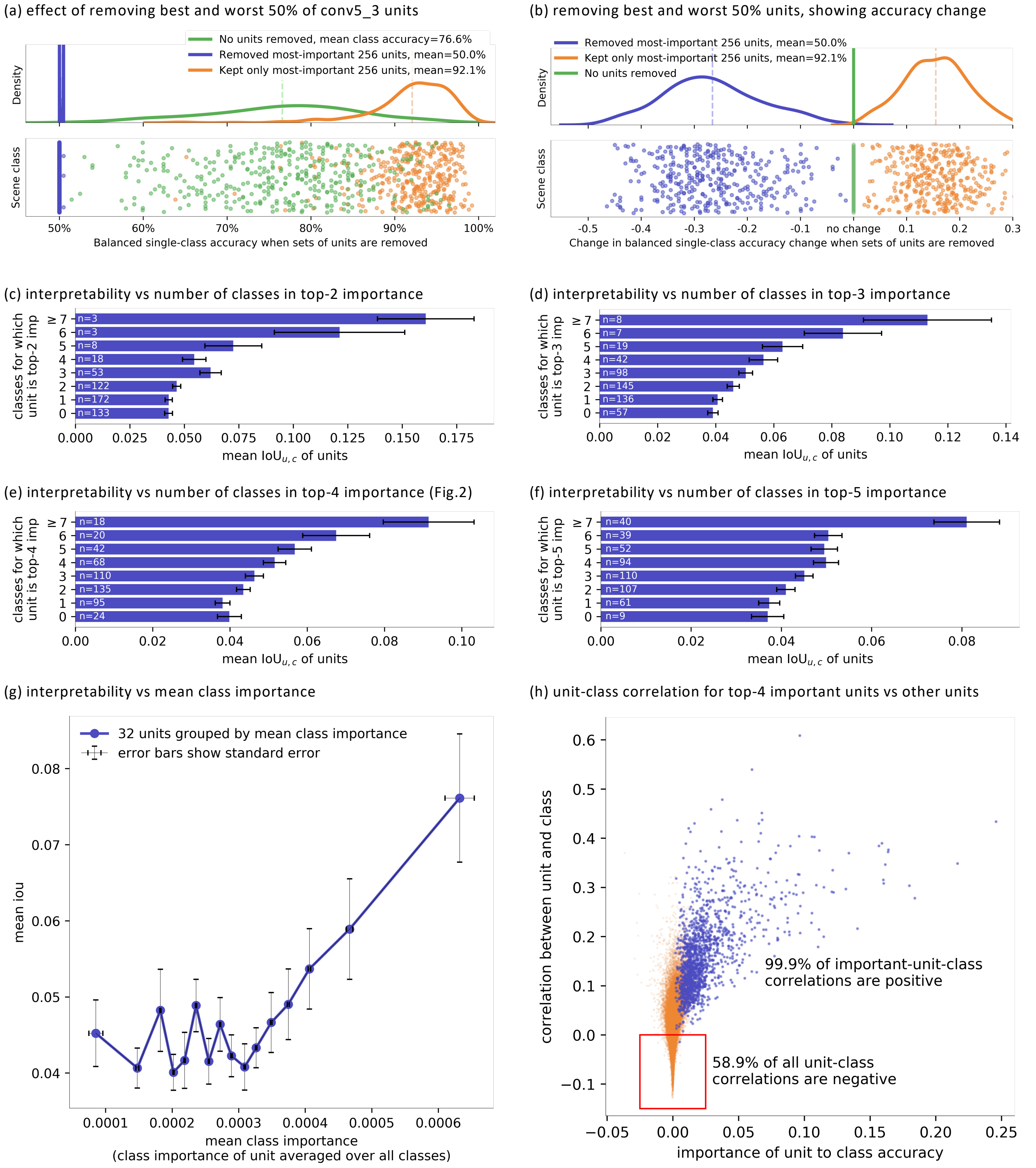

Fig. S4. (a) The effect of removing the least-important 256 (out of 512) units for each class. Although no retraining is done, removal of these units increases single-class binary classification accuracy for the chosen class from an average of 76.6% to 92.1%. (b) The same data plotted as changes from the original network accuracy on the class, showing that removing the most-import 256 units always damages accuracy and removing the least-import 256 units always improves accuracy for the class. (c-f) Mean IoU$_{u,c}$ is higher for units that are important for more output scene classes; this finding is insensitive to the way we count importance. (c) shows the results for top-2 importance of units; (d) top-3; (e) top-4; (f) top-5. (g) The mean class importance of a unit is the single-class accuracy drop caused by the removal of the unit averaged over all 365 classes. When units are bucketed by mean class importance, the most-important units more closely match human-interpretable concepts as measured by higher IoU. (h) Importance and Pearson's correlation between activation and class for top-4 important units for each class, plotted in blue; less important units for each class are in orange. While most unit-class pairs show a negative correlation, almost all unit-class correlations for important units are positive. The network learns no specific negative correlations.

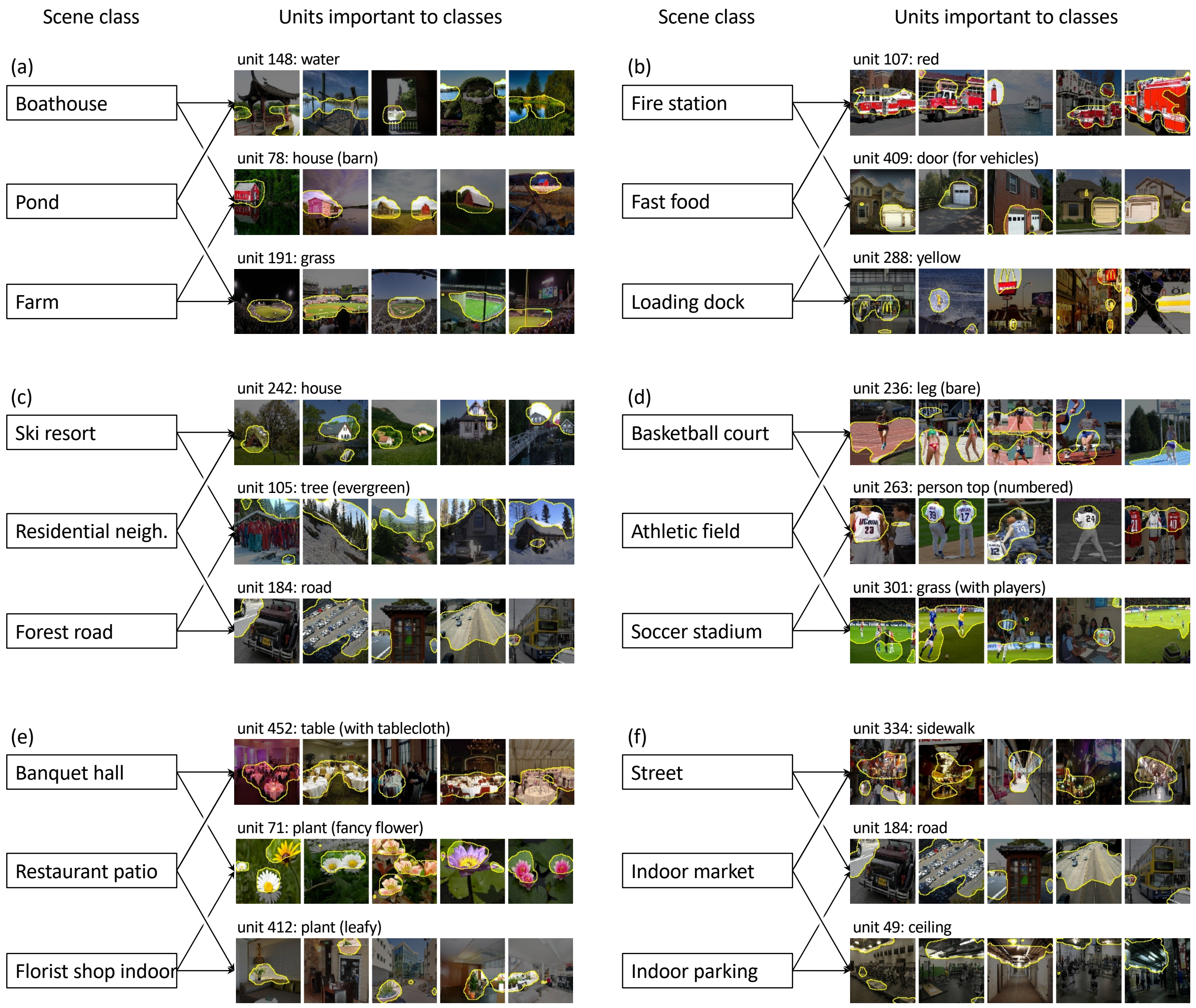

Fig. S5. Combinations of important units that contribute to an output class reveal the structure of the classification model learned by the network. Here we show that a different subset of three units is important to different output class. (a) A boathouse is a barn on the water; a pond is water with a grassy field; a farm is a grassy field with a barn. (b) yellow and red without a garage door signal fast food; red with a garage door is a fire station; yellow with one is a loading dock. (c) two important ski resort units are also important for residential neighborhoods and forest roads, but those classes also need to see roads. (d) three sport fields can be distinguished: bare legs are seen in basketball and athletic fields but not soccer; numbered jerseys show up in basketball and soccer but not athletic fields; and basketball courts do not have grass. (e) the distinction between a banquet hall and a restaurant patio is the type of plants, which can be seen in visualization although the segmentation does not distinguish them: flowers or leafy plants. (f) the presence of a ceiling indicates an indoor parking lot or an indoor market rather than a street scene.

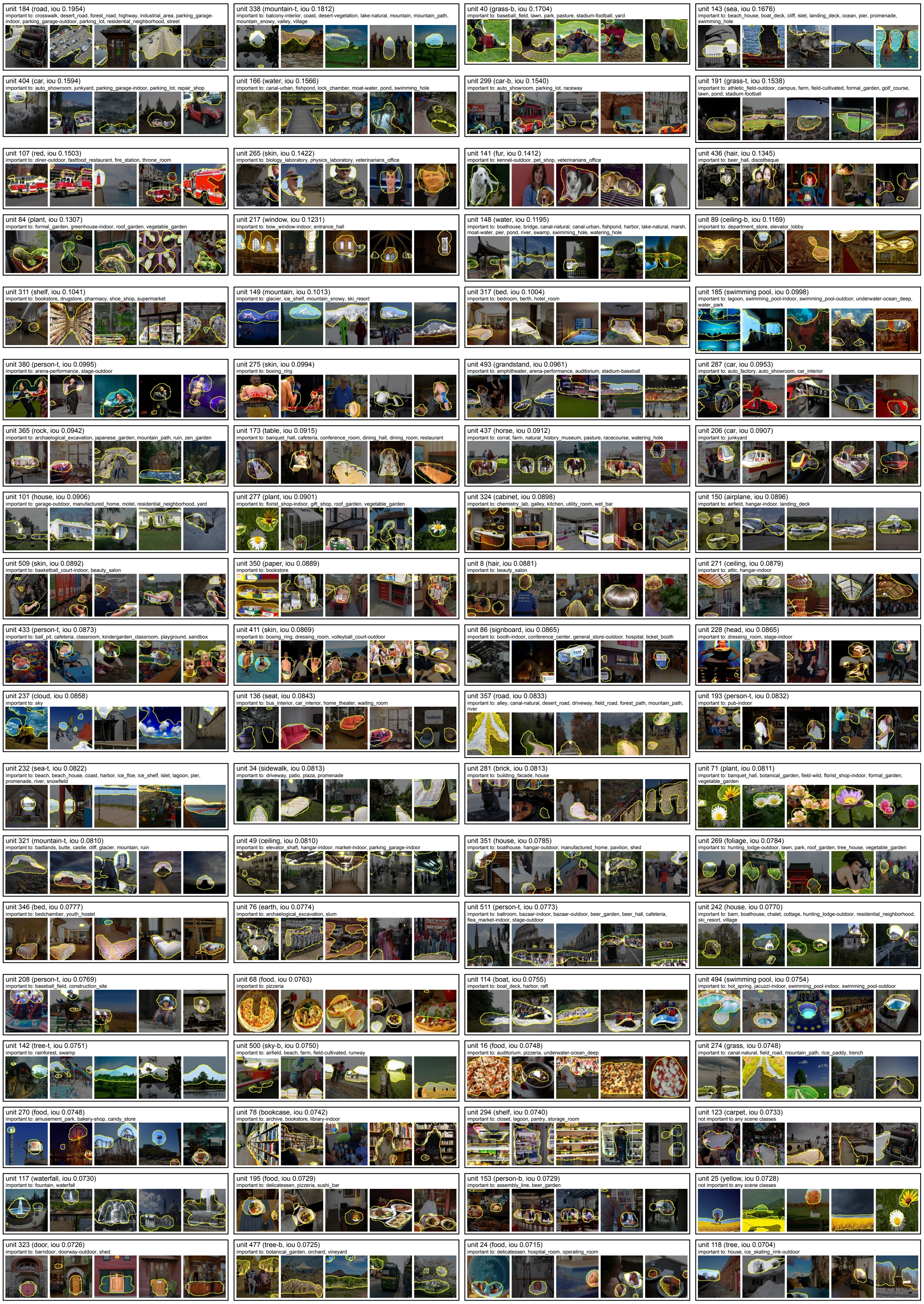
unit 184 (road, iou 0.1954)
important to: crosswalk, desert_road, forest_road, highway, industrial_area, parking_garage-indoor, parking_garage-outdoor, parking_lot, residential_neighborhood, street
unit 338 (mountain-t, iou 0.1812)
important to: balcony-interior, coast, desert-vegetation, lake-natural, mountain, mountain_path, mountain_snowy, valley, village
unit 40 (grass-b, iou 0.1704)
important to: baseball_field, lawn, park, pasture, stadium-football, yard
unit 143 (sea, iou 0.1676)
important to: beach_house, boat_deck, cliff, islet, landing_deck, ocean, pier, promenade, swimming_hole
unit 404 (car, iou 0.1594)
important to: auto_showroom, junkyard, parking_garage-indoor, parking_lot, repair_shop
unit 166 (water, iou 0.1566)
important to: canal-urban, fishpond, lock_chamber, moat-water, pond, swimming_hole
unit 299 (car-b, iou 0.1540)
important to: auto_showroom, parking_lot, raceway
unit 191 (grass-t, iou 0.1538)
important to: athletic_field-outdoor, campus, farm, field-cultivated, formal_garden, golf_course, lawn, pond, stadium-football
unit 107 (red, iou 0.1503)
important to: diner-outdoor, fastfood_restaurant, fire_station, throne_room
unit 265 (skin, iou 0.1422)
important to: biology_laboratory, physics_laboratory, veterinarians_office
unit 141 (fur, iou 0.1412)
important to: kennel-outdoor, pet_shop, veterinarians_office
unit 436 (hair, iou 0.1345)
important to: beer_hall, discotheque
unit 84 (plant, iou 0.1307)
important to: formal_garden, greenhouse-indoor, roof_garden, vegetable_garden
unit 217 (window, iou 0.1231)
important to: bow_window-indoor, entrance_hall
unit 148 (water, iou 0.1195)
important to: boathouse, bridge, canal-natural, canal-urban, fishpond, harbor, lake-natural, marsh, moat-water, pier, pond, river, swamp, swimming_hole, watering_hole
unit 89 (ceiling-b, iou 0.1169)
important to: department_store, elevator_lobby
unit 311 (shelf, iou 0.1041)
important to: bookstore, drugstore, pharmacy, shoe_shop, supermarket
unit 149 (mountain, iou 0.1013)
important to: glacier, ice_shelf, mountain_snowy, ski_resort
unit 317 (bed, iou 0.1004)
important to: bedroom, berth, hotel_room
unit 185 (swimming pool, iou 0.0998)
important to: lagoon, swimming_pool-indoor, swimming_pool-outdoor, underwater-ocean_deep, water_park
unit 380 (person-t, iou 0.0995)
important to: arena-performance, stage-outdoor
unit 275 (skin, iou 0.0994)
important to: boxing_ring
unit 493 (grandstand, iou 0.0961)
important to: amphitheater, arena-performance, auditorium, stadium-baseball
unit 287 (car, iou 0.0953)
important to: auto_factory, auto_showroom, car_interior
unit 365 (rock, iou 0.0942)
important to: archaelogical_excavation, japanese_garden, mountain_path, ruin, zen_garden
unit 173 (table, iou 0.0915)
important to: banquet_hall, cafeteria, conference_room, dining_hall, dining_room, restaurant
unit 437 (horse, iou 0.0912)
important to: corral, farm, natural_history_museum, pasture, racecourse, watering_hole
unit 206 (car, iou 0.0907)
important to: junkyard
unit 101 (house, iou 0.0906)
important to: garage-outdoor, manufactured_home, motel, residential_neighborhood, yard
unit 277 (plant, iou 0.0901)
important to: florist_shop-indoor, gift_shop, roof_garden, vegetable_garden
unit 324 (cabinet, iou 0.0898)
important to: chemistry_lab, galley, kitchen, utility_room, wet_bar
unit 150 (airplane, iou 0.0896)
important to: airfield, hangar-indoor, landing_deck
unit 509 (skin, iou 0.0892)
important to: basketball_court-indoor, beauty_salon
unit 350 (paper, iou 0.0889)
important to: bookstore
unit 8 (hair, iou 0.0881)
important to: beauty_salon
unit 271 (ceiling, iou 0.0879)
important to: attic, hangar-indoor
unit 433 (person-t, iou 0.0873)
important to: ball_pit, cafeteria, classroom, kindergarden_classroom, playground, sandbox
unit 411 (skin, iou 0.0869)
important to: boxing_ring, dressing_room, volleyball_court-outdoor
unit 86 (signboard, iou 0.0865)
important to: booth-indoor, conference_center, general_store-outdoor, hospital, ticket_booth
unit 228 (head, iou 0.0865)
important to: dressing_room, stage-indoor
unit 237 (cloud, iou 0.0858)
important to: sky
unit 136 (seat, iou 0.0843)
important to: bus_interior, car_interior, home_theater, waiting_room
unit 357 (road, iou 0.0833)
important to: alley, canal-natural, desert_road, driveway, field_road, forest_path, mountain_path, river
unit 193 (person-t, iou 0.0832)
important to: pub-indoor
unit 232 (sea-t, iou 0.0822)
important to: beach, beach_house, coast, harbor, ice_floe, ice_shelf, islet, lagoon, pier, promenade, river, snowfield
unit 34 (sidewalk, iou 0.0813)
important to: driveway, patio, plaza, promenade
unit 281 (brick, iou 0.0813)
important to: building_facade, house
unit 71 (plant, iou 0.0811)
important to: banquet_hall, botanical_garden, field-wild, florist_shop-indoor, formal_garden, vegetable_garden
unit 321 (mountain-t, iou 0.0810)
important to: badlands, butte, castle, cliff, glacier, mountain, ruin
unit 49 (ceiling, iou 0.0810)
important to: elevator_shaft, hangar-indoor, market-indoor, parking_garage-indoor
unit 351 (house, iou 0.0785)
important to: boathouse, hangar-outdoor, manufactured_home, pavilion, shed
unit 269 (foliage, iou 0.0784)
important to: hunting_lodge-outdoor, lawn, park, roof_garden, tree_house, vegetable_garden
unit 346 (bed, iou 0.0777)
important to: bedchamber, youth_hostel
unit 76 (earth, iou 0.0774)
important to: archaelogical_excavation, slum
unit 511 (person-t, iou 0.0773)
important to: ballroom, bazaar-indoor, bazaar-outdoor, beer_garden, beer_hall, cafeteria, flea_market-indoor, stage-outdoor
unit 242 (house, iou 0.0770)
important to: barn, boathouse, chalet, cottage, hunting_lodge-outdoor, residential_neighborhood, ski_resort, village
unit 208 (person-t, iou 0.0769)
important to: baseball_field, construction_site
unit 68 (food, iou 0.0763)
important to: pizzeria
unit 114 (boat, iou 0.0755)
important to: boat_deck, harbor, raft
unit 494 (swimming pool, iou 0.0754)
important to: hot_spring, jacuzzi-indoor, swimming_pool-indoor, swimming_pool-outdoor
unit 142 (tree-t, iou 0.0751)
important to: rainforest, swamp
unit 500 (sky-b, iou 0.0750)
important to: airfield, beach, farm, field-cultivated, runway
unit 16 (food, iou 0.0748)
important to: auditorium, pizzeria, underwater-ocean_deep
unit 274 (grass, iou 0.0748)
important to: canal-natural, field_road, mountain_path, rice_paddy, trench
unit 270 (food, iou 0.0748)
important to: amusement_park, bakery-shop, candy_store
unit 78 (bookcase, iou 0.0742)
important to: archive, bookstore, library-indoor
unit 294 (shelf, iou 0.0740)
important to: closet, lagoon, pantry, storage_room
unit 123 (carpet, iou 0.0733)
not important to any scene classes
unit 117 (waterfall, iou 0.0730)
important to: fountain, waterfall
unit 195 (food, iou 0.0729)
important to: delicatessen, pizzeria, sushi_bar
unit 153 (person-b, iou 0.0729)
important to: assembly_line, beer_garden
unit 25 (yellow, iou 0.0728)
not important to any scene classes
unit 323 (door, iou 0.0726)
important to: barndoor, doorway-outdoor, shed
unit 477 (tree-b, iou 0.0725)
important to: botanical_garden, orchard, vineyard
unit 24 (food, iou 0.0715)
important to: delicatessen, hospital_room, operating_room
unit 118 (tree, iou 0.0704)
important to: house, ice_skating_rink-outdoor

Fig. S6. Comparing all units of `conv5_3` of VGG16, 1 of 7. For each unit, the top five activating images are shown from the Places365 validation set, highlighting regions where the activation spikes above the top 1% quantile. Each unit is listed with the best-matching segmented concept and all output scene classes for which the unit is among the top four important units. Units are sorted in descending order of IoU agreement with a segmented concept.

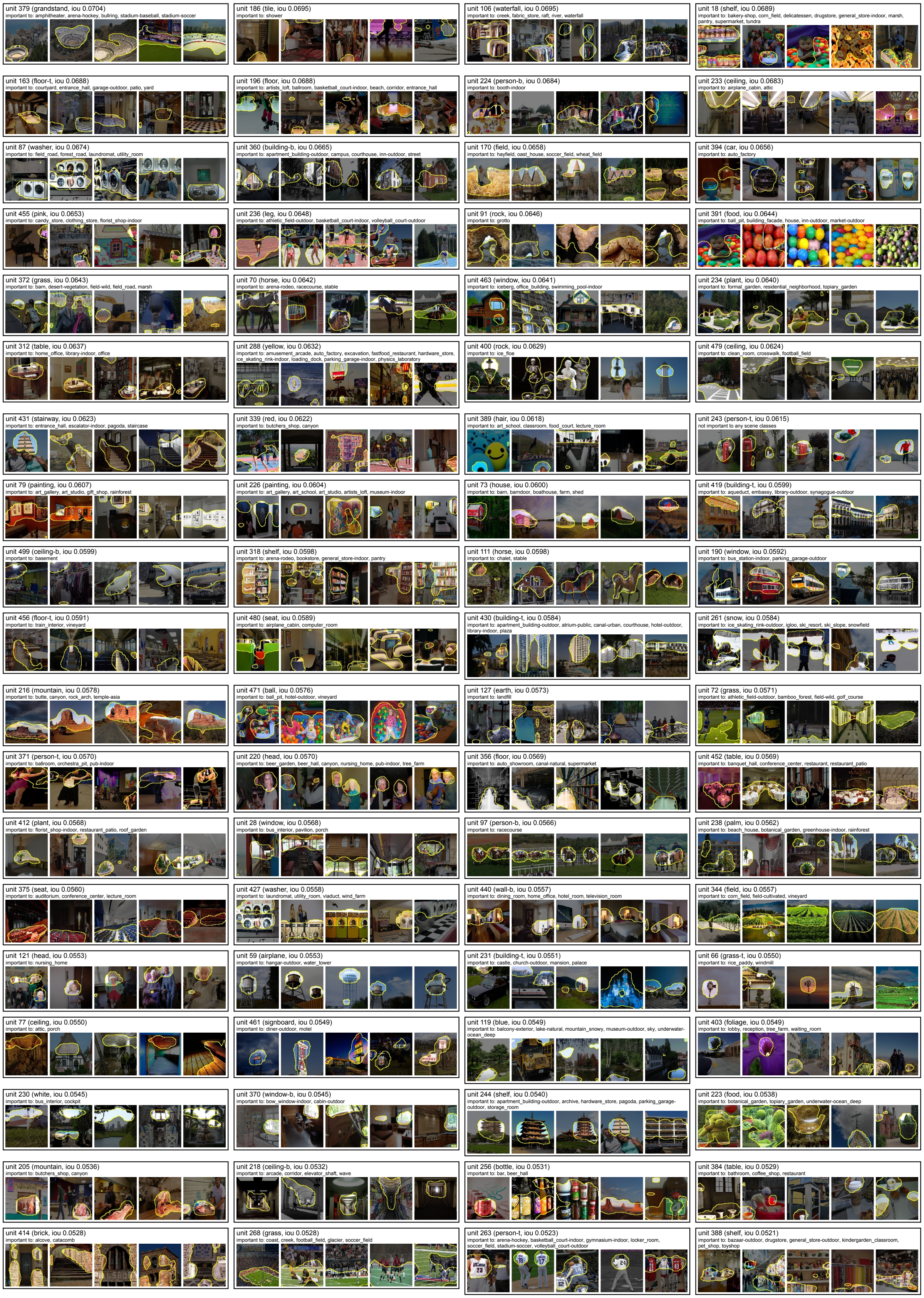
unit 379 (grandstand, iou 0.0704)
important to: amphitheater, arena-hockey, bullring, stadium-baseball, stadium-soccer
unit 186 (tile, iou 0.0695)
important to: shower
unit 106 (waterfall, iou 0.0695)
important to: creek, fabric_store, raft, river, waterfall
unit 18 (shelf, iou 0.0689)
important to: bakery-shop, corn_field, delicatessen, drugstore, general_store-indoor, marsh, pantry, supermarket, tundra
unit 163 (floor-t, iou 0.0688)
important to: courtyard, entrance_hall, garage-outdoor, patio, yard
unit 196 (floor, iou 0.0688)
important to: artists_loft, ballroom, basketball_court-indoor, beach, corridor, entrance_hall
unit 224 (person-b, iou 0.0684)
important to: booth-indoor
unit 233 (ceiling, iou 0.0683)
important to: airplane_cabin, attic
unit 87 (washer, iou 0.0674)
important to: field_road, forest_road, laundromat, utility_room
unit 360 (building-b, iou 0.0665)
important to: apartment_building-outdoor, campus, courthouse, inn-outdoor, street
unit 170 (field, iou 0.0658)
important to: hayfield, oast_house, soccer_field, wheat_field
unit 394 (car, iou 0.0656)
important to: auto_factory
unit 455 (pink, iou 0.0653)
important to: candy_store, clothing_store, florist_shop-indoor
unit 236 (leg, iou 0.0648)
important to: athletic_field-outdoor, basketball_court-indoor, volleyball_court-outdoor
unit 91 (rock, iou 0.0646)
important to: grotto
unit 391 (food, iou 0.0644)
important to: ball_pit, building_facade, house, inn-outdoor, market-outdoor
unit 372 (grass, iou 0.0643)
important to: barn, desert-vegetation, field-wild, field_road, marsh
unit 70 (horse, iou 0.0642)
important to: arena-rodeo, racecourse, stable
unit 463 (window, iou 0.0641)
important to: iceberg, office_building, swimming_pool-indoor
unit 234 (plant, iou 0.0640)
important to: formal_garden, residential_neighborhood, topiary_garden
unit 312 (table, iou 0.0637)
important to: home_office, library-indoor, office
unit 288 (yellow, iou 0.0632)
important to: amusement_arcade, auto_factory, excavation, fastfood_restaurant, hardware_store, ice_skating_rink-indoor, loading_dock, parking_garage-indoor, physics_laboratory
unit 400 (rock, iou 0.0629)
important to: ice_floe
unit 479 (ceiling, iou 0.0624)
important to: clean_room, crosswalk, football_field
unit 431 (stairway, iou 0.0623)
important to: entrance_hall, escalator-indoor, pagoda, staircase
unit 339 (red, iou 0.0622)
important to: butchers_shop, canyon
unit 389 (hair, iou 0.0618)
important to: art_school, classroom, food_court, lecture_room
unit 243 (person-t, iou 0.0615)
not important to any scene classes
unit 79 (painting, iou 0.0607)
important to: art_gallery, art_studio, gift_shop, rainforest
unit 226 (painting, iou 0.0604)
important to: art_gallery, art_school, art_studio, artists_loft, museum-indoor
unit 73 (house, iou 0.0600)
important to: barn, barndoor, boathouse, farm, shed
unit 419 (building-t, iou 0.0599)
important to: aqueduct, embassy, library-outdoor, synagogue-outdoor
unit 499 (ceiling-b, iou 0.0599)
important to: basement
unit 318 (shelf, iou 0.0598)
important to: arena-rodeo, bookstore, general_store-indoor, pantry
unit 111 (horse, iou 0.0598)
important to: chalet, stable
unit 190 (window, iou 0.0592)
important to: bus_station-indoor, parking_garage-outdoor
unit 456 (floor-t, iou 0.0591)
important to: train_interior, vineyard
unit 480 (seat, iou 0.0589)
important to: airplane_cabin, computer_room
unit 430 (building-t, iou 0.0584)
important to: apartment_building-outdoor, atrium-public, canal-urban, courthouse, hotel-outdoor, library-indoor, plaza
unit 261 (snow, iou 0.0584)
important to: ice_skating_rink-outdoor, igloo, ski_resort, ski_slope, snowfield
unit 216 (mountain, iou 0.0578)
important to: butte, canyon, rock_arch, temple-asia
unit 471 (ball, iou 0.0576)
important to: ball_pit, hotel-outdoor, vineyard
unit 127 (earth, iou 0.0573)
important to: landfill
unit 72 (grass, iou 0.0571)
important to: athletic_field-outdoor, bamboo_forest, field-wild, golf_course
unit 371 (person-t, iou 0.0570)
important to: ballroom, orchestra_pit, pub-indoor
unit 220 (head, iou 0.0570)
important to: beer_garden, beer_hall, canyon, nursing_home, pub-indoor, tree_farm
unit 356 (floor, iou 0.0569)
important to: auto_showroom, canal-natural, supermarket
unit 452 (table, iou 0.0569)
important to: banquet_hall, conference_center, restaurant, restaurant_patio
unit 412 (plant, iou 0.0568)
important to: florist_shop-indoor, restaurant_patio, roof_garden
unit 28 (window, iou 0.0568)
important to: bus_interior, pavilion, porch
unit 97 (person-b, iou 0.0566)
important to: racecourse
unit 238 (palm, iou 0.0562)
important to: beach_house, botanical_garden, greenhouse-indoor, rainforest
unit 375 (seat, iou 0.0560)
important to: auditorium, conference_center, lecture_room
unit 427 (washer, iou 0.0558)
important to: laundromat, utility_room, viaduct, wind_farm
unit 440 (wall-b, iou 0.0557)
important to: dining_room, home_office, hotel_room, television_room
unit 344 (field, iou 0.0557)
important to: corn_field, field-cultivated, vineyard
unit 121 (head, iou 0.0553)
important to: nursing_home
unit 59 (airplane, iou 0.0553)
important to: hangar-outdoor, water_tower
unit 231 (building-t, iou 0.0551)
important to: castle, church-outdoor, mansion, palace
unit 66 (grass-t, iou 0.0550)
important to: rice_paddy, windmill
unit 77 (ceiling, iou 0.0550)
important to: attic, porch
unit 461 (signboard, iou 0.0549)
important to: diner-outdoor, motel
unit 119 (blue, iou 0.0549)
important to: balcony-exterior, lake-natural, mountain_snowy, museum-outdoor, sky, underwater-ocean_deep
unit 403 (foliage, iou 0.0549)
important to: lobby, reception, tree_farm, waiting_room
unit 230 (white, iou 0.0545)
important to: bus_interior, cockpit
unit 370 (window-b, iou 0.0545)
important to: bow_window-indoor, cabin-outdoor
unit 244 (shelf, iou 0.0540)
important to: apartment_building-outdoor, archive, hardware_store, pagoda, parking_garage-outdoor, storage_room
unit 223 (food, iou 0.0538)
important to: botanical_garden, topiary_garden, underwater-ocean_deep
unit 205 (mountain, iou 0.0536)
important to: butchers_shop, canyon
unit 218 (ceiling-b, iou 0.0532)
important to: arcade, corridor, elevator_shaft, wave
unit 256 (bottle, iou 0.0531)
important to: bar, beer_hall
unit 384 (table, iou 0.0529)
important to: bathroom, coffee_shop, restaurant
unit 414 (brick, iou 0.0528)
important to: alcove, catacomb
unit 268 (grass, iou 0.0528)
important to: coast, creek, football_field, glacier, soccer_field
unit 263 (person-t, iou 0.0523)
important to: arena-hockey, basketball_court-indoor, gymnasium-indoor, locker_room, soccer_field, stadium-soccer, volleyball_court-outdoor
unit 388 (shelf, iou 0.0521)
important to: bazaar-outdoor, drugstore, general_store-outdoor, kindergarden_classroom, pet_shop, toyshop

Fig. S7. Comparing all units of `conv5_3` of VGG16, 2 of 7.

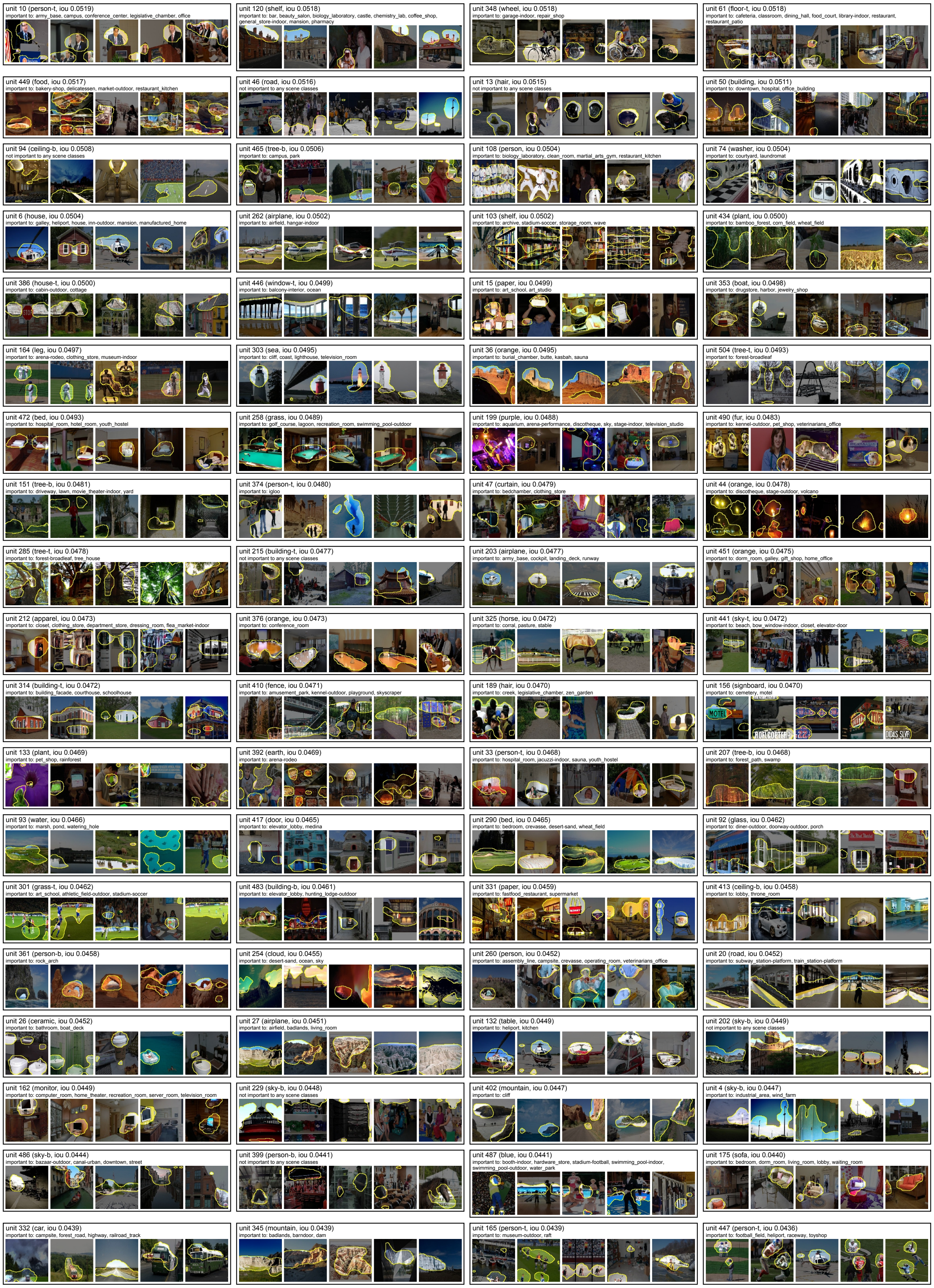
unit 10 (person-t, iou 0.0519)
important to: army_base, campus, conference_center, legislative_chamber, office
unit 120 (shelf, iou 0.0518)
important to: bar, beauty_salon, biology_laboratory, castle, chemistry_lab, coffee_shop, general_store-indoor, mansion, pharmacy
unit 348 (wheel, iou 0.0518)
important to: garage-indoor, repair_shop
unit 61 (floor-t, iou 0.0518)
important to: cafeteria, classroom, dining_hall, food_court, library-indoor, restaurant, restaurant_patio
unit 449 (food, iou 0.0517)
important to: bakery-shop, delicatessen, market-outdoor, restaurant_kitchen
unit 46 (road, iou 0.0516)
not important to any scene classes
unit 13 (hair, iou 0.0515)
not important to any scene classes
unit 50 (building, iou 0.0511)
important to: downtown, hospital, office_building
unit 94 (ceiling-b, iou 0.0508)
not important to any scene classes
unit 465 (tree-b, iou 0.0506)
important to: campus, park
unit 108 (person, iou 0.0504)
important to: biology_laboratory, clean_room, martial_arts_gym, restaurant_kitchen
unit 74 (washer, iou 0.0504)
important to: courtyard, laundromat
unit 6 (house, iou 0.0504)
important to: galley, heliport, house, inn-outdoor, mansion, manufactured_home
unit 262 (airplane, iou 0.0502)
important to: airfield, hangar-indoor
unit 103 (shelf, iou 0.0502)
important to: archive, stadium-soccer, storage_room, wave
unit 434 (plant, iou 0.0500)
important to: bamboo_forest, corn_field, wheat_field
unit 386 (house-t, iou 0.0500)
important to: cabin-outdoor, cottage
unit 446 (window-t, iou 0.0499)
important to: balcony-interior, ocean
unit 15 (paper, iou 0.0499)
important to: art_school, art_studio
unit 353 (boat, iou 0.0498)
important to: drugstore, harbor, jewelry_shop
unit 164 (leg, iou 0.0497)
important to: arena-rodeo, clothing_store, museum-indoor
unit 303 (sea, iou 0.0495)
important to: cliff, coast, lighthouse, television_room
unit 36 (orange, iou 0.0495)
important to: burial_chamber, butte, kasbah, sauna
unit 504 (tree-t, iou 0.0493)
important to: forest-broadleaf
unit 472 (bed, iou 0.0493)
important to: hospital_room, hotel_room, youth_hostel
unit 258 (grass, iou 0.0489)
important to: golf_course, lagoon, recreation_room, swimming_pool-outdoor
unit 199 (purple, iou 0.0488)
important to: aquarium, arena-performance, discotheque, sky, stage-indoor, television_studio
unit 490 (fur, iou 0.0483)
important to: kennel-outdoor, pet_shop, veterinarians_office
unit 151 (tree-b, iou 0.0481)
important to: driveway, lawn, movie_theater-indoor, yard
unit 374 (person-t, iou 0.0480)
important to: igloo
unit 47 (curtain, iou 0.0479)
important to: bedchamber, clothing_store
unit 44 (orange, iou 0.0478)
important to: discotheque, stage-outdoor, volcano
unit 285 (tree-t, iou 0.0478)
important to: forest-broadleaf, tree_house
unit 215 (building-t, iou 0.0477)
not important to any scene classes
unit 203 (airplane, iou 0.0477)
important to: army_base, cockpit, landing_deck, runway
unit 451 (orange, iou 0.0475)
important to: dorm_room, galley, gift_shop, home_office
unit 212 (apparel, iou 0.0473)
important to: closet, clothing_store, department_store, dressing_room, flea_market-indoor
unit 376 (orange, iou 0.0473)
important to: conference_room
unit 325 (horse, iou 0.0472)
important to: corral, pasture, stable
unit 441 (sky-t, iou 0.0472)
important to: beach, bow_window-indoor, closet, elevator-door
unit 314 (building-t, iou 0.0472)
important to: building_facade, courthouse, schoolhouse
unit 410 (fence, iou 0.0471)
important to: amusement_park, kennel-outdoor, playground, skyscraper
unit 189 (hair, iou 0.0470)
important to: creek, legislative_chamber, zen_garden
unit 156 (signboard, iou 0.0470)
important to: cemetery, motel
unit 133 (plant, iou 0.0469)
important to: pet_shop, rainforest
unit 392 (earth, iou 0.0469)
important to: arena-rodeo
unit 33 (person-t, iou 0.0468)
important to: hospital_room, jacuzzi-indoor, sauna, youth_hostel
unit 207 (tree-b, iou 0.0468)
important to: forest_path, swamp
unit 93 (water, iou 0.0466)
important to: marsh, pond, watering_hole
unit 417 (door, iou 0.0465)
important to: elevator_lobby, medina
unit 290 (bed, iou 0.0465)
important to: bedroom, crevasse, desert-sand, wheat_field
unit 92 (glass, iou 0.0462)
important to: diner-outdoor, doorway-outdoor, porch
unit 301 (grass-t, iou 0.0462)
important to: art_school, athletic_field-outdoor, stadium-soccer
unit 483 (building-b, iou 0.0461)
important to: elevator_lobby, hunting_lodge-outdoor
unit 331 (paper, iou 0.0459)
important to: fastfood_restaurant, supermarket
unit 413 (ceiling-b, iou 0.0458)
important to: lobby, throne_room
unit 361 (person-b, iou 0.0458)
important to: rock_arch
unit 254 (cloud, iou 0.0455)
important to: desert-sand, ocean, sky
unit 260 (person, iou 0.0452)
important to: assembly_line, campsite, crevasse, operating_room, veterinarians_office
unit 20 (road, iou 0.0452)
important to: subway_station-platform, train_station-platform
unit 26 (ceramic, iou 0.0452)
important to: bathroom, boat_deck
unit 27 (airplane, iou 0.0451)
important to: airfield, badlands, living_room
unit 132 (table, iou 0.0449)
important to: heliport, kitchen
unit 202 (sky-b, iou 0.0449)
not important to any scene classes
unit 162 (monitor, iou 0.0449)
important to: computer_room, home_theater, recreation_room, server_room, television_room
unit 229 (sky-b, iou 0.0448)
not important to any scene classes
unit 402 (mountain, iou 0.0447)
important to: cliff
unit 4 (sky-b, iou 0.0447)
important to: industrial_area, wind_farm
unit 486 (sky-b, iou 0.0444)
important to: bazaar-outdoor, canal-urban, downtown, street
unit 399 (person-b, iou 0.0441)
not important to any scene classes
unit 487 (blue, iou 0.0441)
important to: booth-indoor, hardware_store, stadium-football, swimming_pool-indoor, swimming_pool-outdoor, water_park
unit 175 (sofa, iou 0.0440)
important to: bedroom, dorm_room, living_room, lobby, waiting_room
unit 332 (car, iou 0.0439)
important to: campsite, forest_road, highway, railroad_track
unit 345 (mountain, iou 0.0439)
important to: badlands, barndoor, dam
unit 165 (person-t, iou 0.0439)
important to: museum-outdoor, raft
unit 447 (person-t, iou 0.0436)
important to: football_field, heliport, raceway, toyshop

Fig. S8. Comparing all units of `conv5_3` of VGG16, 3 of 7.

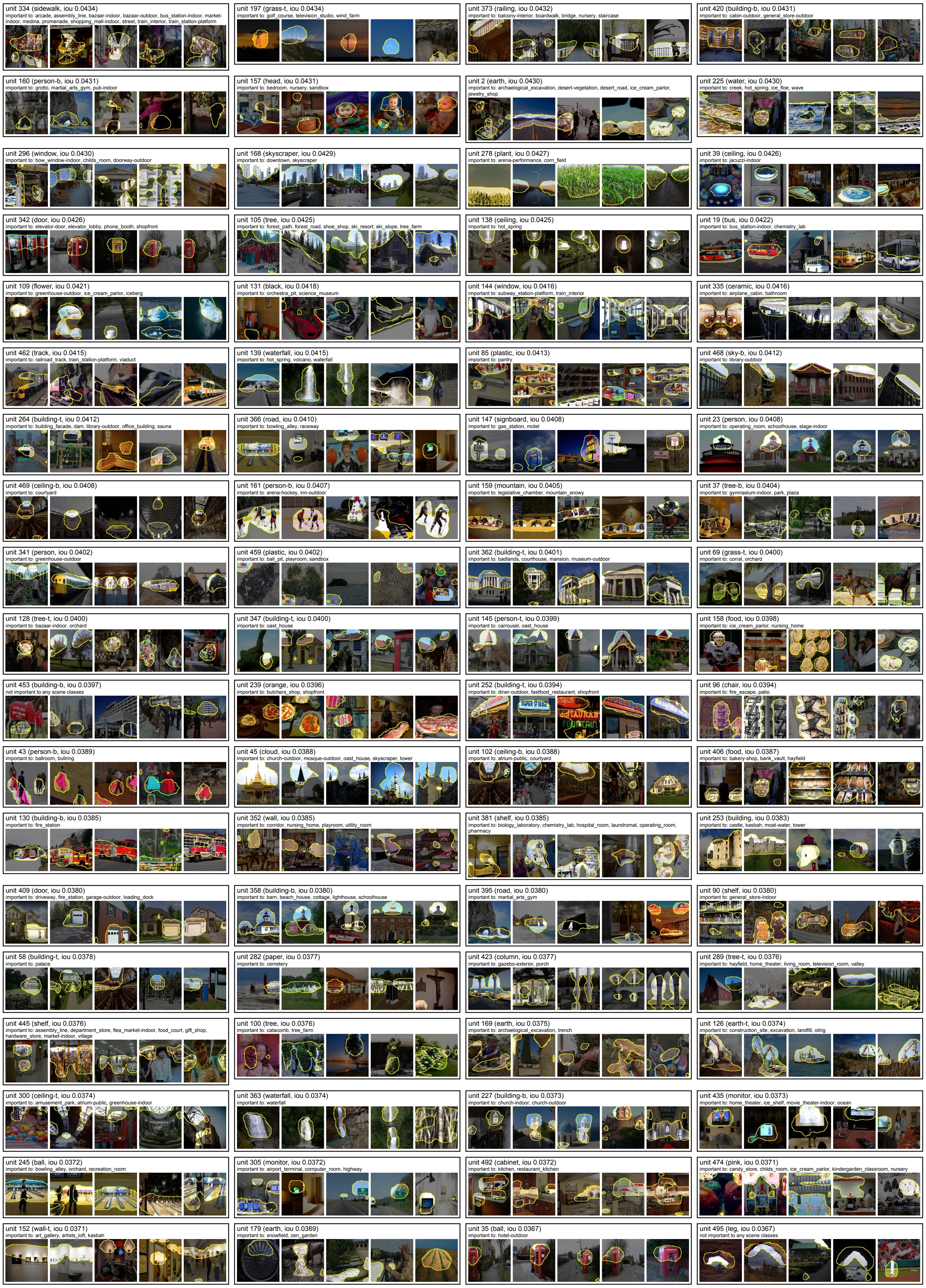
unit 334 (sidewalk, iou 0.0434)
important to: arcade, assembly_line, bazaar-indoor, bazaar-outdoor, bus_station-indoor, market-indoor, medina, promenade, shopping_mall-indoor, street, train_interior, train_station-platform
unit 197 (grass-t, iou 0.0434)
important to: golf_course, television_studio, wind_farm
unit 373 (railing, iou 0.0432)
important to: balcony-interior, boardwalk, bridge, nursery, staircase
unit 420 (building-b, iou 0.0431)
important to: cabin-outdoor, general_store-outdoor
unit 160 (person-b, iou 0.0431)
important to: grotto, martial_arts_gym, pub-indoor
unit 157 (head, iou 0.0431)
important to: bedroom, nursery, sandbox
unit 2 (earth, iou 0.0430)
important to: archaelogical_excavation, desert-vegetation, desert_road, ice_cream_parlor, jewelry_shop
unit 225 (water, iou 0.0430)
important to: creek, hot_spring, ice_floe, wave
unit 296 (window, iou 0.0430)
important to: bow_window-indoor, childs_room, doorway-outdoor
unit 168 (skyscraper, iou 0.0429)
important to: downtown, skyscraper
unit 278 (plant, iou 0.0427)
important to: arena-performance, corn_field
unit 39 (ceiling, iou 0.0426)
important to: jacuzzi-indoor
unit 342 (door, iou 0.0426)
important to: elevator-door, elevator_lobby, phone_booth, shopfront
unit 105 (tree, iou 0.0425)
important to: forest_path, forest_road, shoe_shop, ski_resort, ski_slope, tree_farm
unit 138 (ceiling, iou 0.0425)
important to: hot_spring
unit 19 (bus, iou 0.0422)
important to: bus_station-indoor, chemistry_lab
unit 109 (flower, iou 0.0421)
important to: greenhouse-outdoor, ice_cream_parlor, iceberg
unit 131 (black, iou 0.0418)
important to: orchestra_pit, science_museum
unit 144 (window, iou 0.0416)
important to: subway_station-platform, train_interior
unit 335 (ceramic, iou 0.0416)
important to: airplane_cabin, bathroom
unit 462 (track, iou 0.0415)
important to: railroad_track, train_station-platform, viaduct
unit 139 (waterfall, iou 0.0415)
important to: hot_spring, volcano, waterfall
unit 85 (plastic, iou 0.0413)
important to: pantry
unit 468 (sky-b, iou 0.0412)
important to: library-outdoor
unit 264 (building-t, iou 0.0412)
important to: building_facade, dam, library-outdoor, office_building, sauna
unit 366 (road, iou 0.0410)
important to: bowling_alley, raceway
unit 147 (signboard, iou 0.0408)
important to: gas_station, motel
unit 23 (person, iou 0.0408)
important to: operating_room, schoolhouse, stage-indoor
unit 469 (ceiling-b, iou 0.0408)
important to: courtyard
unit 161 (person-b, iou 0.0407)
important to: arena-hockey, inn-outdoor
unit 159 (mountain, iou 0.0405)
important to: legislative_chamber, mountain_snowy
unit 37 (tree-b, iou 0.0404)
important to: gymnasium-indoor, park, plaza
unit 341 (person, iou 0.0402)
important to: greenhouse-outdoor
unit 459 (plastic, iou 0.0402)
important to: ball_pit, playroom, sandbox
unit 362 (building-t, iou 0.0401)
important to: badlands, courthouse, mansion, museum-outdoor
unit 69 (grass-t, iou 0.0400)
important to: corral, orchard
unit 128 (tree-t, iou 0.0400)
important to: bazaar-indoor, orchard
unit 347 (building-t, iou 0.0400)
important to: oast_house
unit 145 (person-t, iou 0.0399)
important to: carrousel, oast_house
unit 158 (food, iou 0.0398)
important to: ice_cream_parlor, nursing_home
unit 453 (building-b, iou 0.0397)
not important to any scene classes
unit 239 (orange, iou 0.0396)
important to: butchers_shop, shopfront
unit 252 (building-t, iou 0.0394)
important to: diner-outdoor, fastfood_restaurant, shopfront
unit 96 (chair, iou 0.0394)
important to: fire_escape, patio
unit 43 (person-b, iou 0.0389)
important to: ballroom, bullring
unit 45 (cloud, iou 0.0388)
important to: church-outdoor, mosque-outdoor, oast_house, skyscraper, tower
unit 102 (ceiling-b, iou 0.0388)
important to: atrium-public, courtyard
unit 406 (food, iou 0.0387)
important to: bakery-shop, bank_vault, hayfield
unit 130 (building-b, iou 0.0385)
important to: fire_station
unit 352 (wall, iou 0.0385)
important to: corridor, nursing_home, playroom, utility_room
unit 381 (shelf, iou 0.0385)
important to: biology_laboratory, chemistry_lab, hospital_room, laundromat, operating_room, pharmacy
unit 253 (building, iou 0.0383)
important to: castle, kasbah, moat-water, tower
unit 409 (door, iou 0.0380)
important to: driveway, fire_station, garage-outdoor, loading_dock
unit 358 (building-b, iou 0.0380)
important to: barn, beach_house, cottage, lighthouse, schoolhouse
unit 395 (road, iou 0.0380)
important to: martial_arts_gym
unit 90 (shelf, iou 0.0380)
important to: general_store-indoor
unit 58 (building-t, iou 0.0378)
important to: palace
unit 282 (paper, iou 0.0377)
important to: cemetery
unit 423 (column, iou 0.0377)
important to: gazebo-exterior, porch
unit 289 (tree-t, iou 0.0376)
important to: hayfield, home_theater, living_room, television_room, valley
unit 445 (shelf, iou 0.0376)
important to: assembly_line, department_store, flea_market-indoor, food_court, gift_shop, hardware_store, market-indoor, village
unit 100 (tree, iou 0.0376)
important to: catacomb, tree_farm
unit 169 (earth, iou 0.0375)
important to: archaelogical_excavation, trench
unit 126 (earth-t, iou 0.0374)
important to: construction_site, excavation, landfill, oilrig
unit 300 (ceiling-t, iou 0.0374)
important to: amusement_park, atrium-public, greenhouse-indoor
unit 363 (waterfall, iou 0.0374)
important to: waterfall
unit 227 (building-b, iou 0.0373)
important to: church-indoor, church-outdoor
unit 435 (monitor, iou 0.0373)
important to: home_theater, ice_shelf, movie_theater-indoor, ocean
unit 245 (ball, iou 0.0372)
important to: bowling_alley, orchard, recreation_room
unit 305 (monitor, iou 0.0372)
important to: airport_terminal, computer_room, highway
unit 492 (cabinet, iou 0.0372)
important to: kitchen, restaurant_kitchen
unit 474 (pink, iou 0.0371)
important to: candy_store, childs_room, ice_cream_parlor, kindergarden_classroom, nursery
unit 152 (wall-t, iou 0.0371)
important to: art_gallery, artists_loft, kasbah
unit 179 (earth, iou 0.0369)
important to: snowfield, zen_garden
unit 35 (ball, iou 0.0367)
important to: hotel-outdoor
unit 495 (leg, iou 0.0367)
not important to any scene classes

Fig. S9. Comparing all units of `conv5_3` of VGG16, 4 of 7.

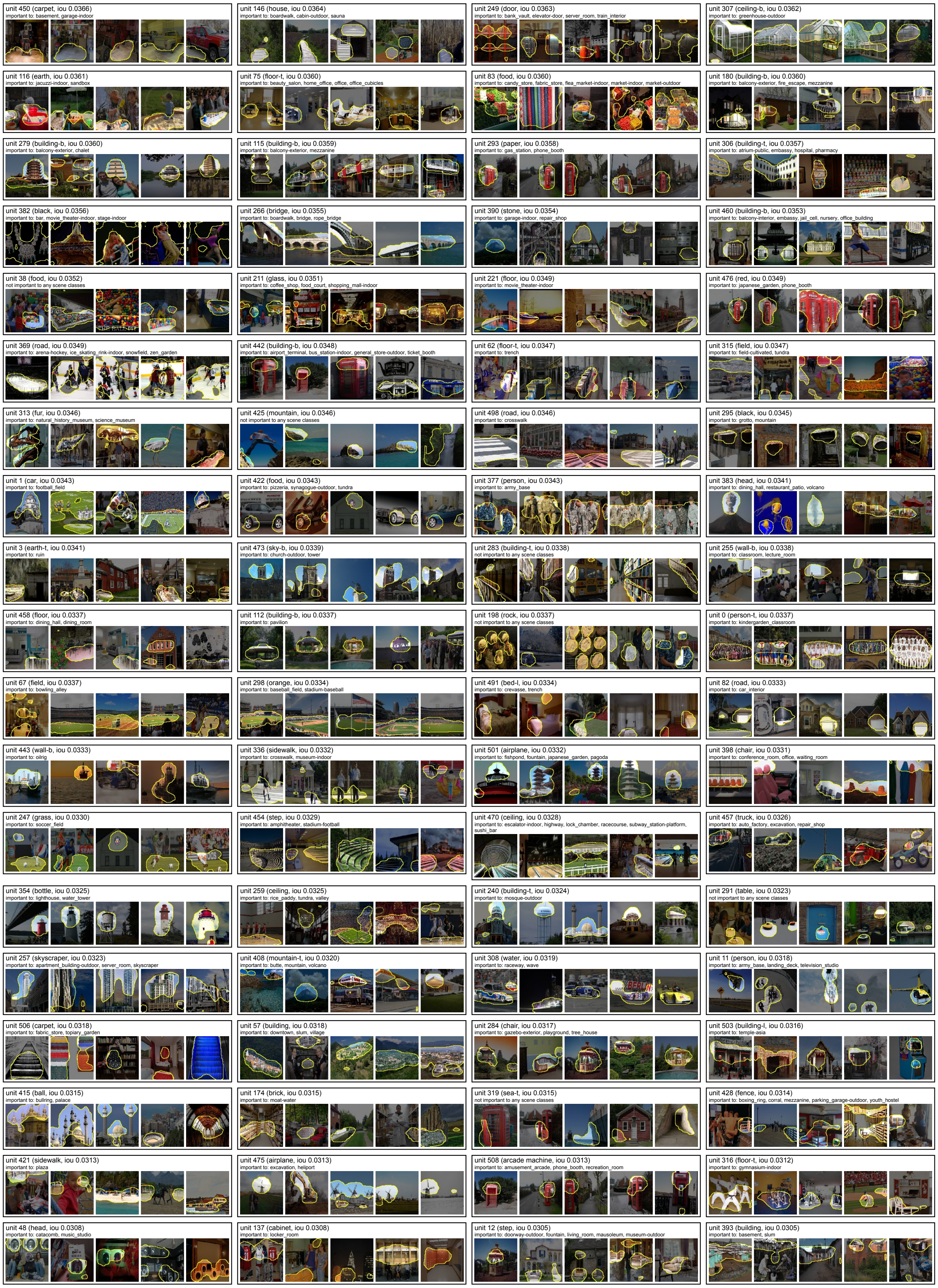
unit 450 (carpet, iou 0.0366)
important to: basement, garage-indoor
unit 146 (house, iou 0.0364)
important to: boardwalk, cabin-outdoor, sauna
unit 249 (door, iou 0.0363)
important to: bank_vault, elevator-door, server_room, train_interior
unit 307 (ceiling-b, iou 0.0362)
important to: greenhouse-outdoor
unit 116 (earth, iou 0.0361)
important to: jacuzzi-indoor, sandbox
unit 75 (floor-t, iou 0.0360)
important to: beauty_salon, home_office, office, office_cubicles
unit 83 (food, iou 0.0360)
important to: candy_store, fabric_store, flea_market-indoor, market-indoor, market-outdoor
unit 180 (building-b, iou 0.0360)
important to: balcony-exterior, fire_escape, mezzanine
unit 279 (building-b, iou 0.0360)
important to: balcony-exterior, chalet
unit 115 (building-b, iou 0.0359)
important to: balcony-exterior, mezzanine
unit 293 (paper, iou 0.0358)
important to: gas_station, phone_booth
unit 306 (building-t, iou 0.0357)
important to: atrium-public, embassy, hospital, pharmacy
unit 382 (black, iou 0.0356)
important to: bar, movie_theater-indoor, stage-indoor
unit 266 (bridge, iou 0.0355)
important to: boardwalk, bridge, rope_bridge
unit 390 (stone, iou 0.0354)
important to: garage-indoor, repair_shop
unit 460 (building-b, iou 0.0353)
important to: balcony-interior, embassy, jail_cell, nursery, office_building
unit 38 (food, iou 0.0352)
not important to any scene classes
unit 211 (glass, iou 0.0351)
important to: coffee_shop, food_court, shopping_mall-indoor
unit 221 (floor, iou 0.0349)
important to: movie_theater-indoor
unit 476 (red, iou 0.0349)
important to: japanese_garden, phone_booth
unit 369 (road, iou 0.0349)
important to: arena-hockey, ice_skating_rink-indoor, snowfield, zen_garden
unit 442 (building-b, iou 0.0348)
important to: airport_terminal, bus_station-indoor, general_store-outdoor, ticket_booth
unit 62 (floor-t, iou 0.0347)
important to: trench
unit 315 (field, iou 0.0347)
important to: field-cultivated, tundra
unit 313 (fur, iou 0.0346)
important to: natural_history_museum, science_museum
unit 425 (mountain, iou 0.0346)
not important to any scene classes
unit 498 (road, iou 0.0346)
important to: crosswalk
unit 295 (black, iou 0.0345)
important to: grotto, mountain
unit 1 (car, iou 0.0343)
important to: football_field
unit 422 (food, iou 0.0343)
important to: pizzeria, synagogue-outdoor, tundra
unit 377 (person, iou 0.0343)
important to: army_base
unit 383 (head, iou 0.0341)
important to: dining_hall, restaurant_patio, volcano
unit 3 (earth-t, iou 0.0341)
important to: ruin
unit 473 (sky-b, iou 0.0339)
important to: church-outdoor, tower
unit 283 (building-t, iou 0.0338)
not important to any scene classes
unit 255 (wall-b, iou 0.0338)
important to: classroom, lecture_room
unit 458 (floor, iou 0.0337)
important to: dining_hall, dining_room
unit 112 (building-b, iou 0.0337)
important to: pavilion
unit 198 (rock, iou 0.0337)
not important to any scene classes
unit 0 (person-t, iou 0.0337)
important to: kindergarden_classroom
unit 67 (field, iou 0.0337)
important to: bowling_alley
unit 298 (orange, iou 0.0334)
important to: baseball_field, stadium-baseball
unit 491 (bed-l, iou 0.0334)
important to: crevasse, trench
unit 82 (road, iou 0.0333)
important to: car_interior
unit 443 (wall-b, iou 0.0333)
important to: oilrig
unit 336 (sidewalk, iou 0.0332)
important to: crosswalk, museum-indoor
unit 501 (airplane, iou 0.0332)
important to: fishpond, fountain, japanese_garden, pagoda
unit 398 (chair, iou 0.0331)
important to: conference_room, office, waiting_room
unit 247 (grass, iou 0.0330)
important to: soccer_field
unit 454 (step, iou 0.0329)
important to: amphitheater, stadium-football
unit 470 (ceiling, iou 0.0328)
important to: escalator-indoor, highway, lock_chamber, racecourse, subway_station-platform, sushi_bar
unit 457 (truck, iou 0.0326)
important to: auto_factory, excavation, repair_shop
unit 354 (bottle, iou 0.0325)
important to: lighthouse, water_tower
unit 259 (ceiling, iou 0.0325)
important to: rice_paddy, tundra, valley
unit 240 (building-t, iou 0.0324)
important to: mosque-outdoor
unit 291 (table, iou 0.0323)
not important to any scene classes
unit 257 (skyscraper, iou 0.0323)
important to: apartment_building-outdoor, server_room, skyscraper
unit 408 (mountain-t, iou 0.0320)
important to: butte, mountain, volcano
unit 308 (water, iou 0.0319)
important to: raceway, wave
unit 11 (person, iou 0.0318)
important to: army_base, landing_deck, television_studio
unit 506 (carpet, iou 0.0318)
important to: fabric_store, topiary_garden
unit 57 (building, iou 0.0318)
important to: downtown, slum, village
unit 284 (chair, iou 0.0317)
important to: gazebo-exterior, playground, tree_house
unit 503 (building-l, iou 0.0316)
important to: temple-asia
unit 415 (ball, iou 0.0315)
important to: bullring, palace
unit 174 (brick, iou 0.0315)
important to: moat-water
unit 319 (sea-t, iou 0.0315)
not important to any scene classes
unit 428 (fence, iou 0.0314)
important to: boxing_ring, corral, mezzanine, parking_garage-outdoor, youth_hostel
unit 421 (sidewalk, iou 0.0313)
important to: plaza
unit 475 (airplane, iou 0.0313)
important to: excavation, heliport
unit 508 (arcade machine, iou 0.0313)
important to: amusement_arcade, phone_booth, recreation_room
unit 316 (floor-t, iou 0.0312)
important to: gymnasium-indoor
unit 48 (head, iou 0.0308)
important to: catacomb, music_studio
unit 137 (cabinet, iou 0.0308)
important to: locker_room
unit 12 (step, iou 0.0305)
important to: doorway-outdoor, fountain, living_room, mausoleum, museum-outdoor
unit 393 (building, iou 0.0305)
important to: basement, slum

Fig. S10. Comparing all units of `conv5_3` of VGG16, 5 of 7.

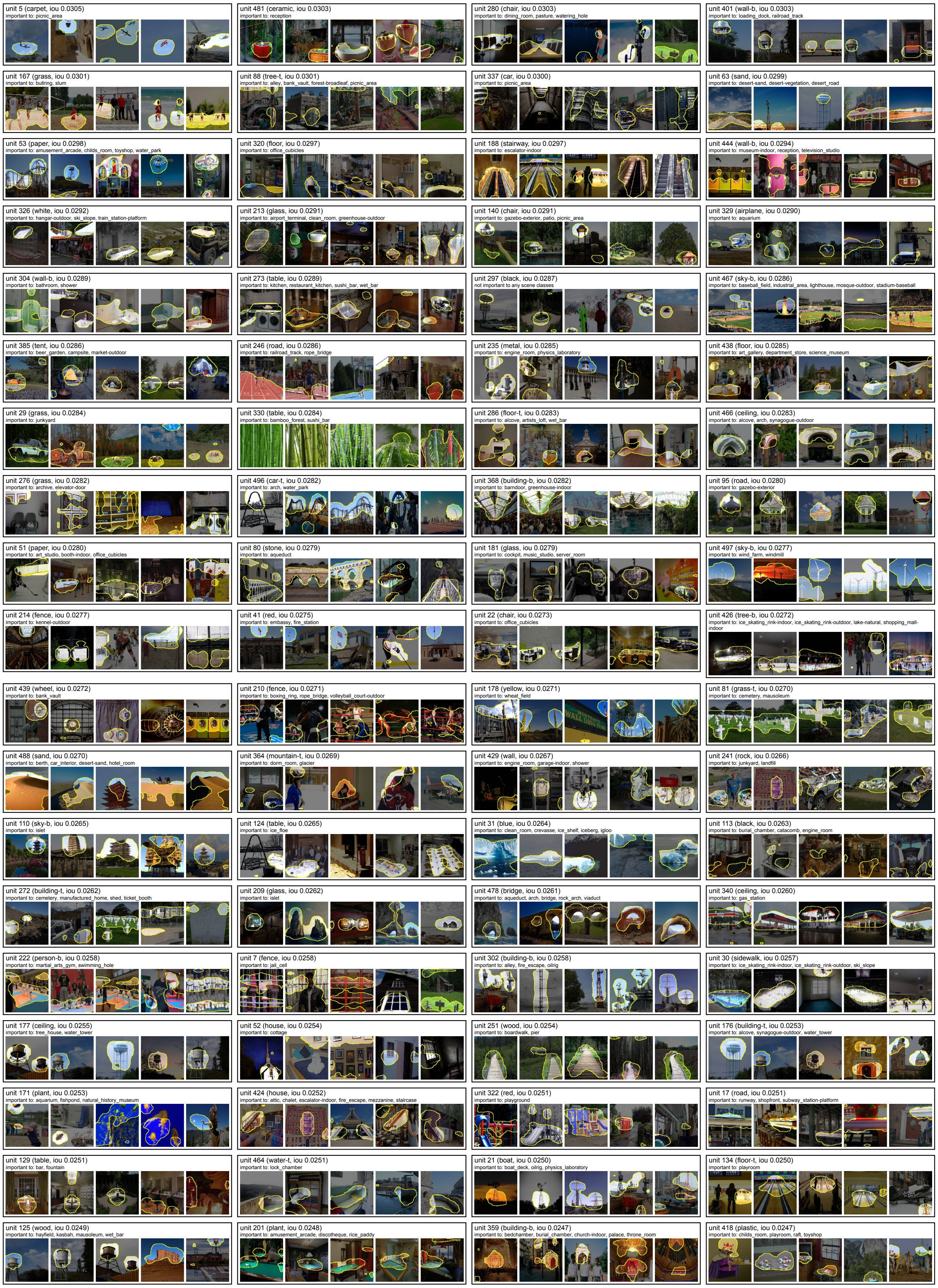
unit 5 (carpet, iou 0.0305)
important to: picnic_area
unit 481 (ceramic, iou 0.0303)
important to: reception
unit 280 (chair, iou 0.0303)
important to: dining_room, pasture, watering_hole
unit 401 (wall-b, iou 0.0303)
important to: loading_dock, railroad_track
unit 167 (grass, iou 0.0301)
important to: bullring, slum
unit 88 (tree-t, iou 0.0301)
important to: alley, bank_vault, forest-broadleaf, picnic_area
unit 337 (car, iou 0.0300)
important to: picnic_area
unit 63 (sand, iou 0.0299)
important to: desert-sand, desert-vegetation, desert_road
unit 53 (paper, iou 0.0298)
important to: amusement_arcade, childs_room, toyshop, water_park
unit 320 (floor, iou 0.0297)
important to: office_cubicles
unit 188 (stairway, iou 0.0297)
important to: escalator-indoor
unit 444 (wall-b, iou 0.0294)
important to: museum-indoor, reception, television_studio
unit 326 (white, iou 0.0292)
important to: hangar-outdoor, ski_slope, train_station-platform
unit 213 (glass, iou 0.0291)
important to: airport_terminal, clean_room, greenhouse-outdoor
unit 140 (chair, iou 0.0291)
important to: gazebo-exterior, patio, picnic_area
unit 329 (airplane, iou 0.0290)
important to: aquarium
unit 304 (wall-b, iou 0.0289)
important to: bathroom, shower
unit 273 (table, iou 0.0289)
important to: kitchen, restaurant_kitchen, sushi_bar, wet_bar
unit 297 (black, iou 0.0287)
not important to any scene classes
unit 467 (sky-b, iou 0.0286)
important to: baseball_field, industrial_area, lighthouse, mosque-outdoor, stadium-baseball
unit 385 (tent, iou 0.0286)
important to: beer_garden, campsite, market-outdoor
unit 246 (road, iou 0.0286)
important to: railroad_track, rope_bridge
unit 235 (metal, iou 0.0285)
important to: engine_room, physics_laboratory
unit 438 (floor, iou 0.0285)
important to: art_gallery, department_store, science_museum
unit 29 (grass, iou 0.0284)
important to: junkyard
unit 330 (table, iou 0.0284)
important to: bamboo_forest, sushi_bar
unit 286 (floor-t, iou 0.0283)
important to: alcove, artists_loft, wet_bar
unit 466 (ceiling, iou 0.0283)
important to: alcove, arch, synagogue-outdoor
unit 276 (grass, iou 0.0282)
important to: archive, elevator-door
unit 496 (car-t, iou 0.0282)
important to: arch, water_park
unit 368 (building-b, iou 0.0282)
important to: barndoor, greenhouse-indoor
unit 95 (road, iou 0.0280)
important to: gazebo-exterior
unit 51 (paper, iou 0.0280)
important to: art_studio, booth-indoor, office_cubicles
unit 80 (stone, iou 0.0279)
important to: aqueduct
unit 181 (glass, iou 0.0279)
important to: cockpit, music_studio, server_room
unit 497 (sky-b, iou 0.0277)
important to: wind_farm, windmill
unit 214 (fence, iou 0.0277)
important to: kennel-outdoor
unit 41 (red, iou 0.0275)
important to: embassy, fire_station
unit 22 (chair, iou 0.0273)
important to: office_cubicles
unit 426 (tree-b, iou 0.0272)
important to: ice_skating_rink-indoor, ice_skating_rink-outdoor, lake-natural, shopping_mall-indoor
unit 439 (wheel, iou 0.0272)
important to: bank_vault
unit 210 (fence, iou 0.0271)
important to: boxing_ring, rope_bridge, volleyball_court-outdoor
unit 178 (yellow, iou 0.0271)
important to: wheat_field
unit 81 (grass-t, iou 0.0270)
important to: cemetery, mausoleum
unit 488 (sand, iou 0.0270)
important to: berth, car_interior, desert-sand, hotel_room
unit 364 (mountain-t, iou 0.0269)
important to: dorm_room, glacier
unit 429 (wall, iou 0.0267)
important to: engine_room, garage-indoor, shower
unit 241 (rock, iou 0.0266)
important to: junkyard, landfill
unit 110 (sky-b, iou 0.0265)
important to: islet
unit 124 (table, iou 0.0265)
important to: ice_floe
unit 31 (blue, iou 0.0264)
important to: clean_room, crevasse, ice_shelf, iceberg, igloo
unit 113 (black, iou 0.0263)
important to: burial_chamber, catacomb, engine_room
unit 272 (building-t, iou 0.0262)
important to: cemetery, manufactured_home, shed, ticket_booth
unit 209 (glass, iou 0.0262)
important to: islet
unit 478 (bridge, iou 0.0261)
important to: aqueduct, arch, bridge, rock_arch, viaduct
unit 340 (ceiling, iou 0.0260)
important to: gas_station
unit 222 (person-b, iou 0.0258)
important to: martial_arts_gym, swimming_hole
unit 7 (fence, iou 0.0258)
important to: jail_cell
unit 302 (building-b, iou 0.0258)
important to: alley, fire_escape, oilrig
unit 30 (sidewalk, iou 0.0257)
important to: ice_skating_rink-indoor, ice_skating_rink-outdoor, ski_slope
unit 177 (ceiling, iou 0.0255)
important to: tree_house, water_tower
unit 52 (house, iou 0.0254)
important to: cottage
unit 251 (wood, iou 0.0254)
important to: boardwalk, pier
unit 176 (building-t, iou 0.0253)
important to: alcove, synagogue-outdoor, water_tower
unit 171 (plant, iou 0.0253)
important to: aquarium, fishpond, natural_history_museum
unit 424 (house, iou 0.0252)
important to: attic, chalet, escalator-indoor, fire_escape, mezzanine, staircase
unit 322 (red, iou 0.0251)
important to: playground
unit 17 (road, iou 0.0251)
important to: runway, shopfront, subway_station-platform
unit 129 (table, iou 0.0251)
important to: bar, fountain
unit 464 (water-t, iou 0.0251)
important to: lock_chamber
unit 21 (boat, iou 0.0250)
important to: boat_deck, oilrig, physics_laboratory
unit 134 (floor-t, iou 0.0250)
important to: playroom
unit 125 (wood, iou 0.0249)
important to: hayfield, kasbah, mausoleum, wet_bar
unit 201 (plant, iou 0.0248)
important to: amusement_arcade, discotheque, rice_paddy
unit 359 (building-b, iou 0.0247)
important to: bedchamber, burial_chamber, church-indoor, palace, throne_room
unit 418 (plastic, iou 0.0247)
important to: childs_room, playroom, raft, toyshop

Fig. S11. Comparing all units of `conv5_3` of VGG16, 6 of 7.

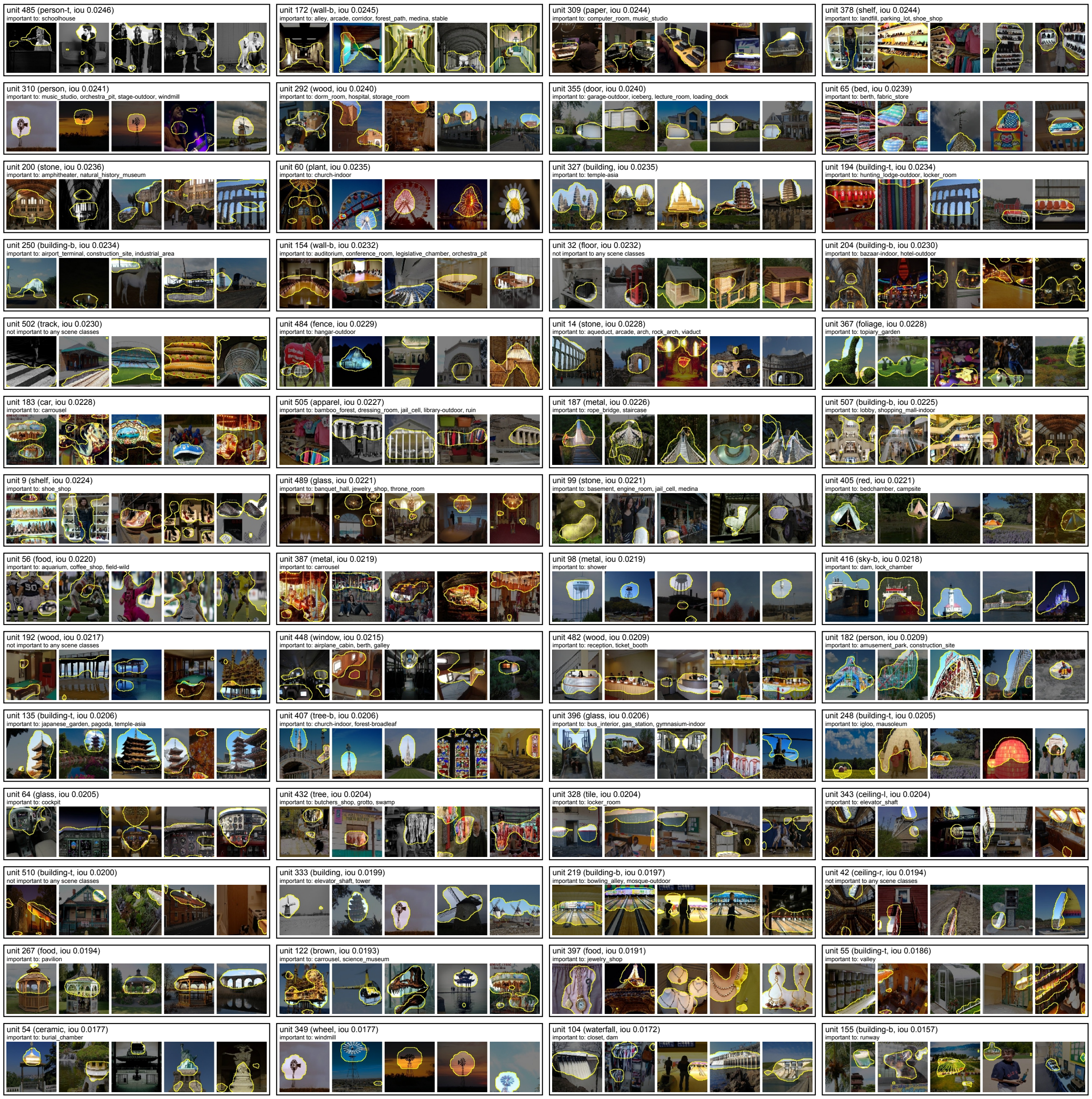
unit 485 (person-t, iou 0.0246)
important to: schoolhouse
unit 172 (wall-b, iou 0.0245)
important to: alley, arcade, corridor, forest_path, medina, stable
unit 309 (paper, iou 0.0244)
important to: computer_room, music_studio
unit 378 (shelf, iou 0.0244)
important to: landfill, parking_lot, shoe_shop
unit 310 (person, iou 0.0241)
important to: music_studio, orchestra_pit, stage-outdoor, windmill
unit 292 (wood, iou 0.0240)
important to: dorm_room, hospital, storage_room
unit 355 (door, iou 0.0240)
important to: garage-outdoor, iceberg, lecture_room, loading_dock
unit 65 (bed, iou 0.0239)
important to: berth, fabric_store
unit 200 (stone, iou 0.0236)
important to: amphitheater, natural_history_museum
unit 60 (plant, iou 0.0235)
important to: church-indoor
unit 327 (building, iou 0.0235)
important to: temple-asia
unit 194 (building-t, iou 0.0234)
important to: hunting_lodge-outdoor, locker_room
unit 250 (building-b, iou 0.0234)
important to: airport_terminal, construction_site, industrial_area
unit 154 (wall-b, iou 0.0232)
important to: auditorium, conference_room, legislative_chamber, orchestra_pit
unit 32 (floor, iou 0.0232)
not important to any scene classes
unit 204 (building-b, iou 0.0230)
important to: bazaar-indoor, hotel-outdoor
unit 502 (track, iou 0.0230)
not important to any scene classes
unit 484 (fence, iou 0.0229)
important to: hangar-outdoor
unit 14 (stone, iou 0.0228)
important to: aqueduct, arcade, arch, rock_arch, viaduct
unit 367 (foliage, iou 0.0228)
important to: topiary_garden
unit 183 (car, iou 0.0228)
important to: carrousel
unit 505 (apparel, iou 0.0227)
important to: bamboo_forest, dressing_room, jail_cell, library-outdoor, ruin
unit 187 (metal, iou 0.0226)
important to: rope_bridge, staircase
unit 507 (building-b, iou 0.0225)
important to: lobby, shopping_mall-indoor
unit 9 (shelf, iou 0.0224)
important to: shoe_shop
unit 489 (glass, iou 0.0221)
important to: banquet_hall, jewelry_shop, throne_room
unit 99 (stone, iou 0.0221)
important to: basement, engine_room, jail_cell, medina
unit 405 (red, iou 0.0221)
important to: bedchamber, campsite
unit 56 (food, iou 0.0220)
important to: aquarium, coffee_shop, field-wild
unit 387 (metal, iou 0.0219)
important to: carrousel
unit 98 (metal, iou 0.0219)
important to: shower
unit 416 (sky-b, iou 0.0218)
important to: dam, lock_chamber
unit 192 (wood, iou 0.0217)
not important to any scene classes
unit 448 (window, iou 0.0215)
important to: airplane_cabin, berth, galley
unit 482 (wood, iou 0.0209)
important to: reception, ticket_booth
unit 182 (person, iou 0.0209)
important to: amusement_park, construction_site
unit 135 (building-t, iou 0.0206)
important to: japanese_garden, pagoda, temple-asia
unit 407 (tree-b, iou 0.0206)
important to: church-indoor, forest-broadleaf
unit 396 (glass, iou 0.0206)
important to: bus_interior, gas_station, gymnasium-indoor
unit 248 (building-t, iou 0.0205)
important to: igloo, mausoleum
unit 64 (glass, iou 0.0205)
important to: cockpit
unit 432 (tree, iou 0.0204)
important to: butchers_shop, grotto, swamp
unit 328 (tile, iou 0.0204)
important to: locker_room
unit 343 (ceiling-l, iou 0.0204)
important to: elevator_shaft
unit 510 (building-t, iou 0.0200)
not important to any scene classes
unit 333 (building, iou 0.0199)
important to: elevator_shaft, tower
unit 219 (building-b, iou 0.0197)
important to: bowling_alley, mosque-outdoor
unit 42 (ceiling-r, iou 0.0194)
not important to any scene classes
unit 267 (food, iou 0.0194)
important to: pavilion
unit 122 (brown, iou 0.0193)
important to: carrousel, science_museum
unit 397 (food, iou 0.0191)
important to: jewelry_shop
unit 55 (building-t, iou 0.0186)
important to: valley
unit 54 (ceramic, iou 0.0177)
important to: burial_chamber
unit 349 (wheel, iou 0.0177)
important to: windmill
unit 104 (waterfall, iou 0.0172)
important to: closet, dam
unit 155 (building-b, iou 0.0157)
important to: runway

Fig. S12. Comparing all units of `conv5_3` of VGG16, 7 of 7.

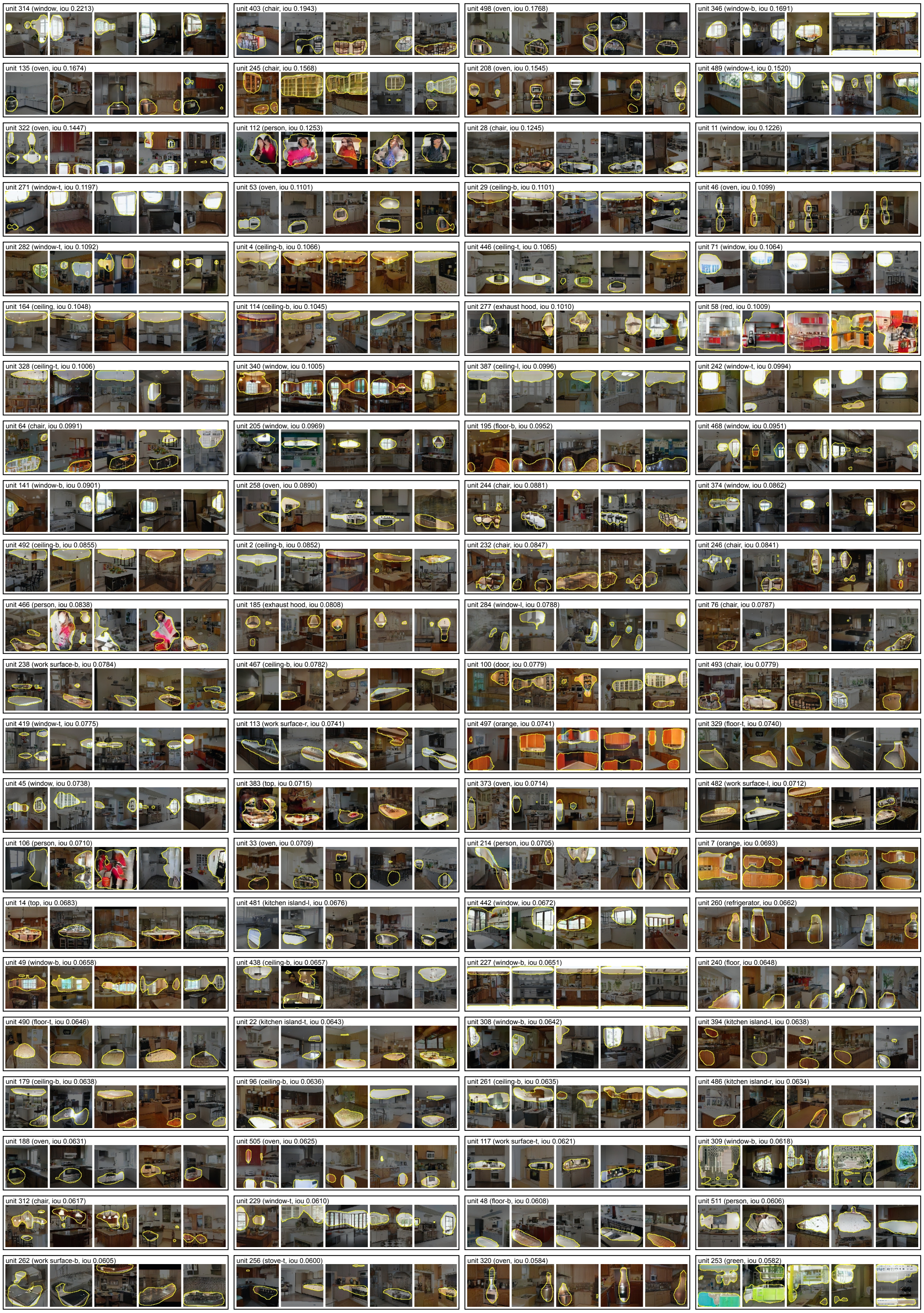
unit 314 (window, iou 0.2213)
unit 403 (chair, iou 0.1943)
unit 498 (oven, iou 0.1768)
unit 346 (window-b, iou 0.1691)
unit 135 (oven, iou 0.1674)
unit 245 (chair, iou 0.1568)
unit 208 (oven, iou 0.1545)
unit 489 (window-t, iou 0.1520)
unit 322 (oven, iou 0.1447)
unit 112 (person, iou 0.1253)
unit 28 (chair, iou 0.1245)
unit 11 (window, iou 0.1226)
unit 271 (window-t, iou 0.1197)
unit 53 (oven, iou 0.1101)
unit 29 (ceiling-b, iou 0.1101)
unit 46 (oven, iou 0.1099)
unit 282 (window-t, iou 0.1092)
unit 4 (ceiling-b, iou 0.1066)
unit 446 (ceiling-t, iou 0.1065)
unit 71 (window, iou 0.1064)
unit 164 (ceiling, iou 0.1048)
unit 114 (ceiling-b, iou 0.1045)
unit 277 (exhaust hood, iou 0.1010)
unit 58 (red, iou 0.1009)
unit 328 (ceiling-t, iou 0.1006)
unit 340 (window, iou 0.1005)
unit 387 (ceiling-l, iou 0.0996)
unit 242 (window-t, iou 0.0994)
unit 64 (chair, iou 0.0991)
unit 205 (window, iou 0.0969)
unit 195 (floor-b, iou 0.0952)
unit 468 (window, iou 0.0951)
unit 141 (window-b, iou 0.0901)
unit 258 (oven, iou 0.0890)
unit 244 (chair, iou 0.0881)
unit 374 (window, iou 0.0862)
unit 492 (ceiling-b, iou 0.0855)
unit 2 (ceiling-b, iou 0.0852)
unit 232 (chair, iou 0.0847)
unit 246 (chair, iou 0.0841)
unit 466 (person, iou 0.0838)
unit 185 (exhaust hood, iou 0.0808)
unit 284 (window-l, iou 0.0788)
unit 76 (chair, iou 0.0787)
unit 238 (work surface-b, iou 0.0784)
unit 467 (ceiling-b, iou 0.0782)
unit 100 (door, iou 0.0779)
unit 493 (chair, iou 0.0779)
unit 419 (window-t, iou 0.0775)
unit 113 (work surface-r, iou 0.0741)
unit 497 (orange, iou 0.0741)
unit 329 (floor-t, iou 0.0740)
unit 45 (window, iou 0.0738)
unit 383 (top, iou 0.0715)
unit 373 (oven, iou 0.0714)
unit 482 (work surface-l, iou 0.0712)
unit 106 (person, iou 0.0710)
unit 33 (oven, iou 0.0709)
unit 214 (person, iou 0.0705)
unit 7 (orange, iou 0.0693)
unit 14 (top, iou 0.0683)
unit 481 (kitchen island-l, iou 0.0676)
unit 442 (window, iou 0.0672)
unit 260 (refrigerator, iou 0.0662)
unit 49 (window-b, iou 0.0658)
unit 438 (ceiling-b, iou 0.0657)
unit 227 (window-b, iou 0.0651)
unit 240 (floor, iou 0.0648)
unit 490 (floor-t, iou 0.0646)
unit 22 (kitchen island-t, iou 0.0643)
unit 308 (window-b, iou 0.0642)
unit 394 (kitchen island-l, iou 0.0638)
unit 179 (ceiling-b, iou 0.0638)
unit 96 (ceiling-b, iou 0.0636)
unit 261 (ceiling-b, iou 0.0635)
unit 486 (kitchen island-r, iou 0.0634)
unit 188 (oven, iou 0.0631)
unit 505 (oven, iou 0.0625)
unit 117 (work surface-t, iou 0.0621)
unit 309 (window-b, iou 0.0618)
unit 312 (chair, iou 0.0617)
unit 229 (window-t, iou 0.0610)
unit 48 (floor-b, iou 0.0608)
unit 511 (person, iou 0.0606)
unit 262 (work surface-b, iou 0.0605)
unit 256 (stove-t, iou 0.0600)
unit 320 (oven, iou 0.0584)
unit 253 (green, iou 0.0582)

Fig. S13. Comparing all units of `layer5` of Progressive GAN kitchen model, 1 of 6. For each unit, the top five activating images are shown from a sample of $10,000$ generated images, highlighting regions where the activation spikes above the top 1% quantile value. Units are sorted in descending order of IoU agreement with a segmented concept.

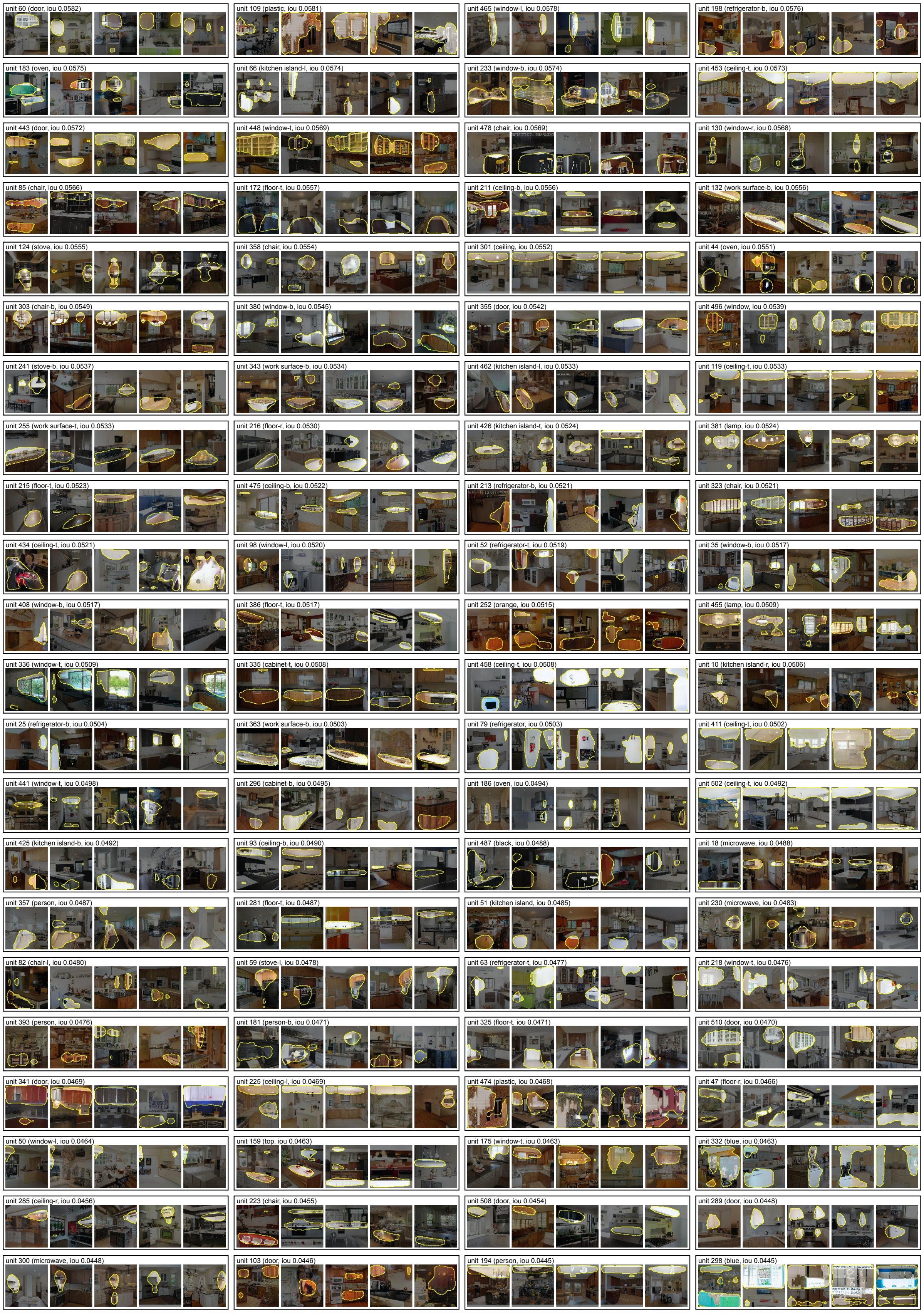
unit 60 (door, iou 0.0582)
unit 109 (plastic, iou 0.0581)
unit 465 (window-l, iou 0.0578)
unit 198 (refrigerator-b, iou 0.0576)
unit 183 (oven, iou 0.0575)
unit 66 (kitchen island-l, iou 0.0574)
unit 233 (window-b, iou 0.0574)
unit 453 (ceiling-t, iou 0.0573)
unit 443 (door, iou 0.0572)
unit 448 (window-t, iou 0.0569)
unit 478 (chair, iou 0.0569)
unit 130 (window-r, iou 0.0568)
unit 85 (chair, iou 0.0566)
unit 172 (floor-t, iou 0.0557)
unit 211 (ceiling-b, iou 0.0556)
unit 132 (work surface-b, iou 0.0556)
unit 124 (stove, iou 0.0555)
unit 358 (chair, iou 0.0554)
unit 301 (ceiling, iou 0.0552)
unit 44 (oven, iou 0.0551)
unit 303 (chair-b, iou 0.0549)
unit 380 (window-b, iou 0.0545)
unit 355 (door, iou 0.0542)
unit 496 (window, iou 0.0539)
unit 241 (stove-b, iou 0.0537)
unit 343 (work surface-b, iou 0.0534)
unit 462 (kitchen island-l, iou 0.0533)
unit 119 (ceiling-t, iou 0.0533)
unit 255 (work surface-t, iou 0.0533)
unit 216 (floor-r, iou 0.0530)
unit 426 (kitchen island-t, iou 0.0524)
unit 381 (lamp, iou 0.0524)
unit 215 (floor-t, iou 0.0523)
unit 475 (ceiling-b, iou 0.0522)
unit 213 (refrigerator-b, iou 0.0521)
unit 323 (chair, iou 0.0521)
unit 434 (ceiling-t, iou 0.0521)
unit 98 (window-l, iou 0.0520)
unit 52 (refrigerator-t, iou 0.0519)
unit 35 (window-b, iou 0.0517)
unit 408 (window-b, iou 0.0517)
unit 386 (floor-t, iou 0.0517)
unit 252 (orange, iou 0.0515)
unit 455 (lamp, iou 0.0509)
unit 336 (window-t, iou 0.0509)
unit 335 (cabinet-t, iou 0.0508)
unit 458 (ceiling-t, iou 0.0508)
unit 10 (kitchen island-r, iou 0.0506)
unit 25 (refrigerator-b, iou 0.0504)
unit 363 (work surface-b, iou 0.0503)
unit 79 (refrigerator, iou 0.0503)
unit 411 (ceiling-t, iou 0.0502)
unit 441 (window-t, iou 0.0498)
unit 296 (cabinet-b, iou 0.0495)
unit 186 (oven, iou 0.0494)
unit 502 (ceiling-t, iou 0.0492)
unit 425 (kitchen island-b, iou 0.0492)
unit 93 (ceiling-b, iou 0.0490)
unit 487 (black, iou 0.0488)
unit 18 (microwave, iou 0.0488)
unit 357 (person, iou 0.0487)
unit 281 (floor-t, iou 0.0487)
unit 51 (kitchen island, iou 0.0485)
unit 230 (microwave, iou 0.0483)
unit 82 (chair-l, iou 0.0480)
unit 59 (stove-l, iou 0.0478)
unit 63 (refrigerator-t, iou 0.0477)
unit 218 (window-t, iou 0.0476)
unit 393 (person, iou 0.0476)
unit 181 (person-b, iou 0.0471)
unit 325 (floor-t, iou 0.0471)
unit 510 (door, iou 0.0470)
unit 341 (door, iou 0.0469)
unit 225 (ceiling-l, iou 0.0469)
unit 474 (plastic, iou 0.0468)
unit 47 (floor-r, iou 0.0466)
unit 50 (window-l, iou 0.0464)
unit 159 (top, iou 0.0463)
unit 175 (window-t, iou 0.0463)
unit 332 (blue, iou 0.0463)
unit 285 (ceiling-r, iou 0.0456)
unit 223 (chair, iou 0.0455)
unit 508 (door, iou 0.0454)
unit 289 (door, iou 0.0448)
unit 300 (microwave, iou 0.0448)
unit 103 (door, iou 0.0446)
unit 194 (person, iou 0.0445)
unit 298 (blue, iou 0.0445)

Fig. S14. Comparing all units of `layer5` of Progressive GAN kitchen model, 2 of 6.

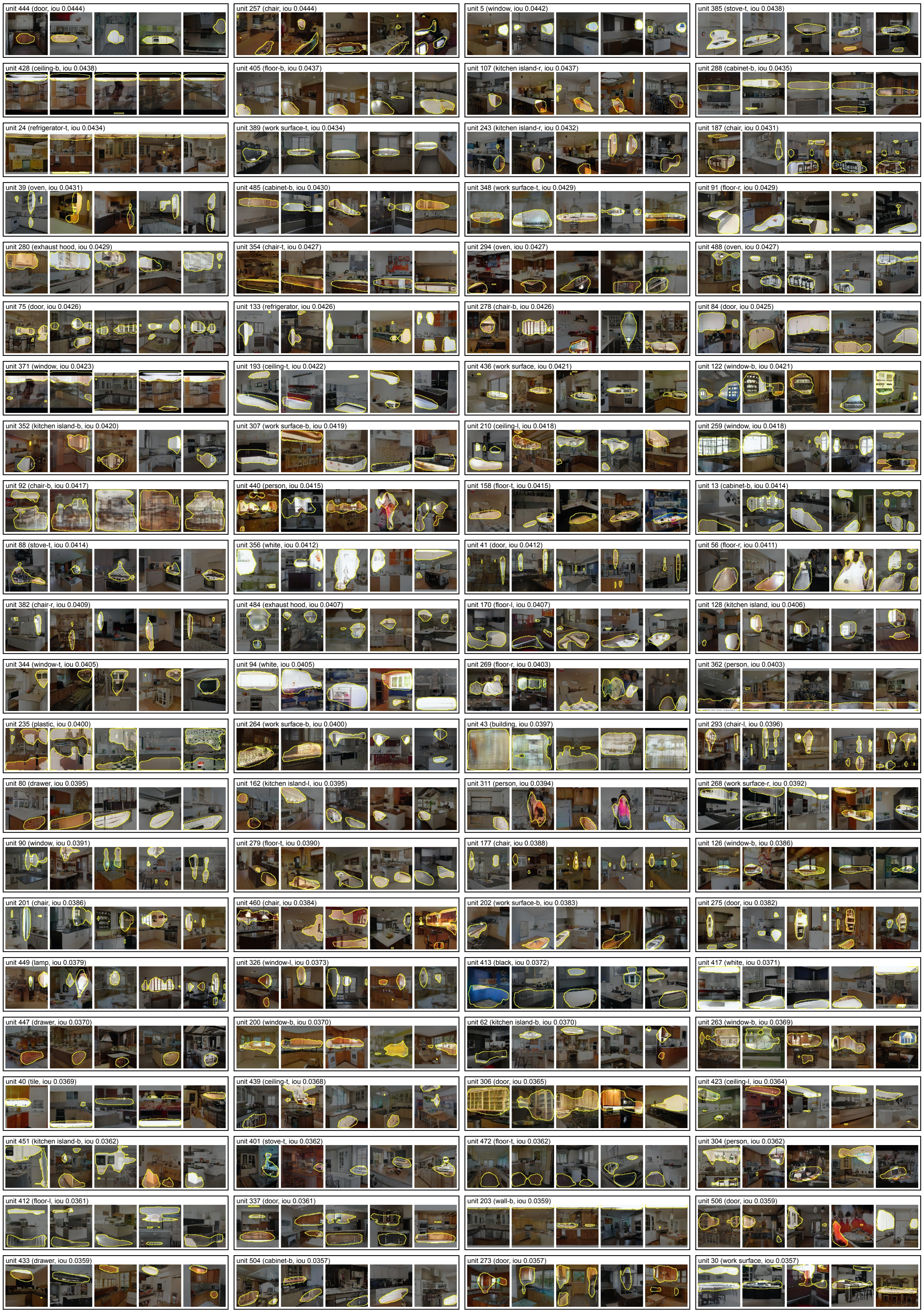
unit 444 (door, iou 0.0444)
unit 257 (chair, iou 0.0444)
unit 5 (window, iou 0.0442)
unit 385 (stove-t, iou 0.0438)
unit 428 (ceiling-b, iou 0.0438)
unit 405 (floor-b, iou 0.0437)
unit 107 (kitchen island-r, iou 0.0437)
unit 288 (cabinet-b, iou 0.0435)
unit 24 (refrigerator-t, iou 0.0434)
unit 389 (work surface-t, iou 0.0434)
unit 243 (kitchen island-r, iou 0.0432)
unit 187 (chair, iou 0.0431)
unit 39 (oven, iou 0.0431)
unit 485 (cabinet-b, iou 0.0430)
unit 348 (work surface-t, iou 0.0429)
unit 91 (floor-r, iou 0.0429)
unit 280 (exhaust hood, iou 0.0429)
unit 354 (chair-t, iou 0.0427)
unit 294 (oven, iou 0.0427)
unit 488 (oven, iou 0.0427)
unit 75 (door, iou 0.0426)
unit 133 (refrigerator, iou 0.0426)
unit 278 (chair-b, iou 0.0426)
unit 84 (door, iou 0.0425)
unit 371 (window, iou 0.0423)
unit 193 (ceiling-t, iou 0.0422)
unit 436 (work surface, iou 0.0421)
unit 122 (window-b, iou 0.0421)
unit 352 (kitchen island-b, iou 0.0420)
unit 307 (work surface-b, iou 0.0419)
unit 210 (ceiling-l, iou 0.0418)
unit 259 (window, iou 0.0418)
unit 92 (chair-b, iou 0.0417)
unit 440 (person, iou 0.0415)
unit 158 (floor-t, iou 0.0415)
unit 13 (cabinet-b, iou 0.0414)
unit 88 (stove-t, iou 0.0414)
unit 356 (white, iou 0.0412)
unit 41 (door, iou 0.0412)
unit 56 (floor-r, iou 0.0411)
unit 382 (chair-r, iou 0.0409)
unit 484 (exhaust hood, iou 0.0407)
unit 170 (floor-l, iou 0.0407)
unit 128 (kitchen island, iou 0.0406)
unit 344 (window-t, iou 0.0405)
unit 94 (white, iou 0.0405)
unit 269 (floor-r, iou 0.0403)
unit 362 (person, iou 0.0403)
unit 235 (plastic, iou 0.0400)
unit 264 (work surface-b, iou 0.0400)
unit 43 (building, iou 0.0397)
unit 293 (chair-l, iou 0.0396)
unit 80 (drawer, iou 0.0395)
unit 162 (kitchen island-l, iou 0.0395)
unit 311 (person, iou 0.0394)
unit 268 (work surface-r, iou 0.0392)
unit 90 (window, iou 0.0391)
unit 279 (floor-t, iou 0.0390)
unit 177 (chair, iou 0.0388)
unit 126 (window-b, iou 0.0386)
unit 201 (chair, iou 0.0386)
unit 460 (chair, iou 0.0384)
unit 202 (work surface-b, iou 0.0383)
unit 275 (door, iou 0.0382)
unit 449 (lamp, iou 0.0379)
unit 326 (window-l, iou 0.0373)
unit 413 (black, iou 0.0372)
unit 417 (white, iou 0.0371)
unit 447 (drawer, iou 0.0370)
unit 200 (window-b, iou 0.0370)
unit 62 (kitchen island-b, iou 0.0370)
unit 263 (window-b, iou 0.0369)
unit 40 (tile, iou 0.0369)
unit 439 (ceiling-t, iou 0.0368)
unit 306 (door, iou 0.0365)
unit 423 (ceiling-l, iou 0.0364)
unit 451 (kitchen island-b, iou 0.0362)
unit 401 (stove-t, iou 0.0362)
unit 472 (floor-t, iou 0.0362)
unit 304 (person, iou 0.0362)
unit 412 (floor-l, iou 0.0361)
unit 337 (door, iou 0.0361)
unit 203 (wall-b, iou 0.0359)
unit 506 (door, iou 0.0359)
unit 433 (drawer, iou 0.0359)
unit 504 (cabinet-b, iou 0.0357)
unit 273 (door, iou 0.0357)
unit 30 (work surface, iou 0.0357)

Fig. S15. Comparing all units of `layer5` of Progressive GAN kitchen model, 3 of 6.

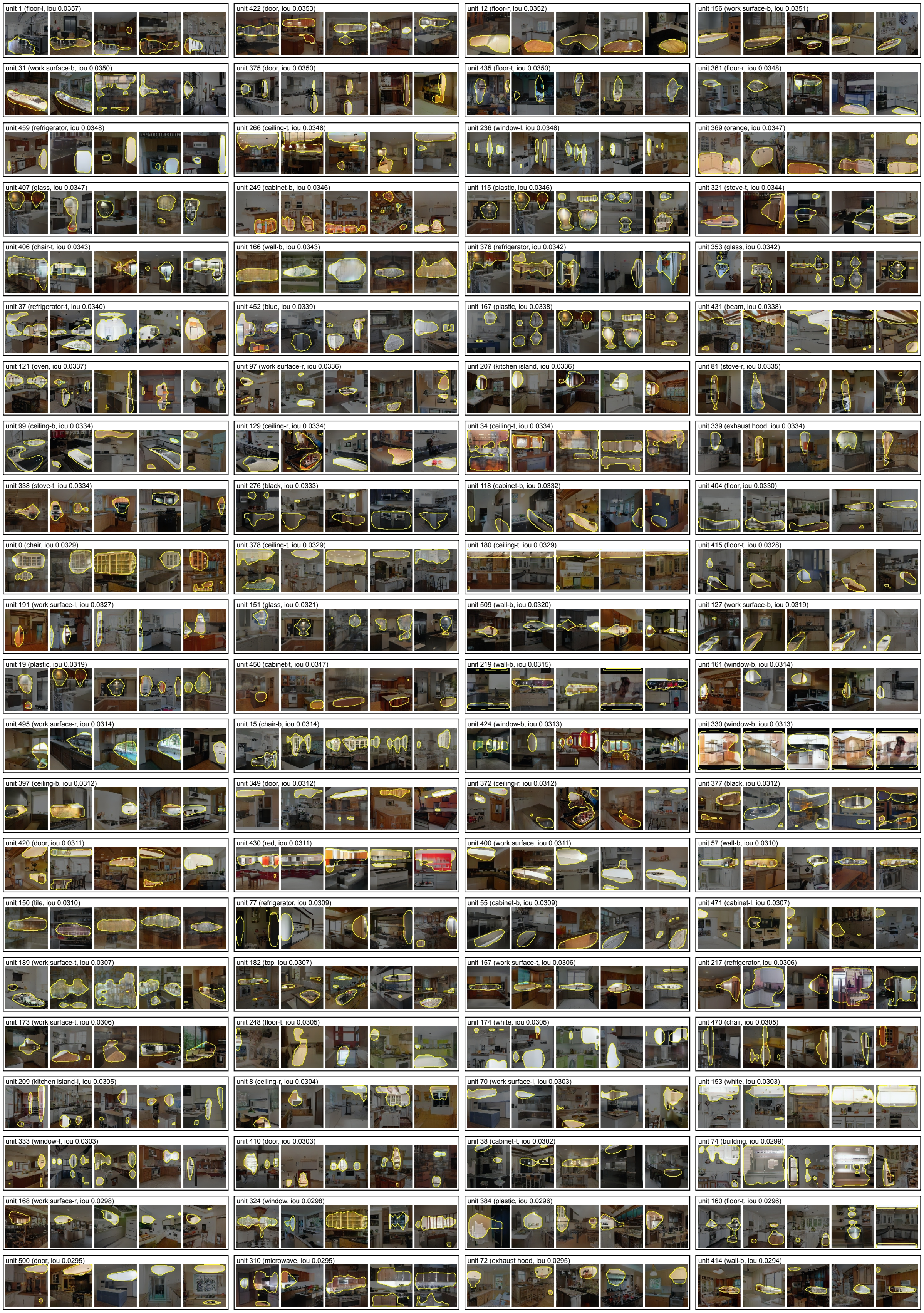
unit 1 (floor-l, iou 0.0357)
unit 422 (door, iou 0.0353)
unit 12 (floor-r, iou 0.0352)
unit 156 (work surface-b, iou 0.0351)
unit 31 (work surface-b, iou 0.0350)
unit 375 (door, iou 0.0350)
unit 435 (floor-t, iou 0.0350)
unit 361 (floor-r, iou 0.0348)
unit 459 (refrigerator, iou 0.0348)
unit 266 (ceiling-t, iou 0.0348)
unit 236 (window-l, iou 0.0348)
unit 369 (orange, iou 0.0347)
unit 407 (glass, iou 0.0347)
unit 249 (cabinet-b, iou 0.0346)
unit 115 (plastic, iou 0.0346)
unit 321 (stove-t, iou 0.0344)
unit 406 (chair-t, iou 0.0343)
unit 166 (wall-b, iou 0.0343)
unit 376 (refrigerator, iou 0.0342)
unit 353 (glass, iou 0.0342)
unit 37 (refrigerator-t, iou 0.0340)
unit 452 (blue, iou 0.0339)
unit 167 (plastic, iou 0.0338)
unit 431 (beam, iou 0.0338)
unit 121 (oven, iou 0.0337)
unit 97 (work surface-r, iou 0.0336)
unit 207 (kitchen island, iou 0.0336)
unit 81 (stove-r, iou 0.0335)
unit 99 (ceiling-b, iou 0.0334)
unit 129 (ceiling-r, iou 0.0334)
unit 34 (ceiling-t, iou 0.0334)
unit 339 (exhaust hood, iou 0.0334)
unit 338 (stove-t, iou 0.0334)
unit 276 (black, iou 0.0333)
unit 118 (cabinet-b, iou 0.0332)
unit 404 (floor, iou 0.0330)
unit 0 (chair, iou 0.0329)
unit 378 (ceiling-t, iou 0.0329)
unit 180 (ceiling-t, iou 0.0329)
unit 415 (floor-t, iou 0.0328)
unit 191 (work surface-l, iou 0.0327)
unit 151 (glass, iou 0.0321)
unit 509 (wall-b, iou 0.0320)
unit 127 (work surface-b, iou 0.0319)
unit 19 (plastic, iou 0.0319)
unit 450 (cabinet-t, iou 0.0317)
unit 219 (wall-b, iou 0.0315)
unit 161 (window-b, iou 0.0314)
unit 495 (work surface-r, iou 0.0314)
unit 15 (chair-b, iou 0.0314)
unit 424 (window-b, iou 0.0313)
unit 330 (window-b, iou 0.0313)
unit 397 (ceiling-b, iou 0.0312)
unit 349 (door, iou 0.0312)
unit 372 (ceiling-r, iou 0.0312)
unit 377 (black, iou 0.0312)
unit 420 (door, iou 0.0311)
unit 430 (red, iou 0.0311)
unit 400 (work surface, iou 0.0311)
unit 57 (wall-b, iou 0.0310)
unit 150 (tile, iou 0.0310)
unit 77 (refrigerator, iou 0.0309)
unit 55 (cabinet-b, iou 0.0309)
unit 471 (cabinet-l, iou 0.0307)
unit 189 (work surface-t, iou 0.0307)
unit 182 (top, iou 0.0307)
unit 157 (work surface-t, iou 0.0306)
unit 217 (refrigerator, iou 0.0306)
unit 173 (work surface-t, iou 0.0306)
unit 248 (floor-t, iou 0.0305)
unit 174 (white, iou 0.0305)
unit 470 (chair, iou 0.0305)
unit 209 (kitchen island-l, iou 0.0305)
unit 8 (ceiling-r, iou 0.0304)
unit 70 (work surface-l, iou 0.0303)
unit 153 (white, iou 0.0303)
unit 333 (window-t, iou 0.0303)
unit 410 (door, iou 0.0303)
unit 38 (cabinet-t, iou 0.0302)
unit 74 (building, iou 0.0299)
unit 168 (work surface-r, iou 0.0298)
unit 324 (window, iou 0.0298)
unit 384 (plastic, iou 0.0296)
unit 160 (floor-t, iou 0.0296)
unit 500 (door, iou 0.0295)
unit 310 (microwave, iou 0.0295)
unit 72 (exhaust hood, iou 0.0295)
unit 414 (wall-b, iou 0.0294)

Fig. S16. Comparing all units of `layer5` of Progressive GAN kitchen model, 4 of 6.

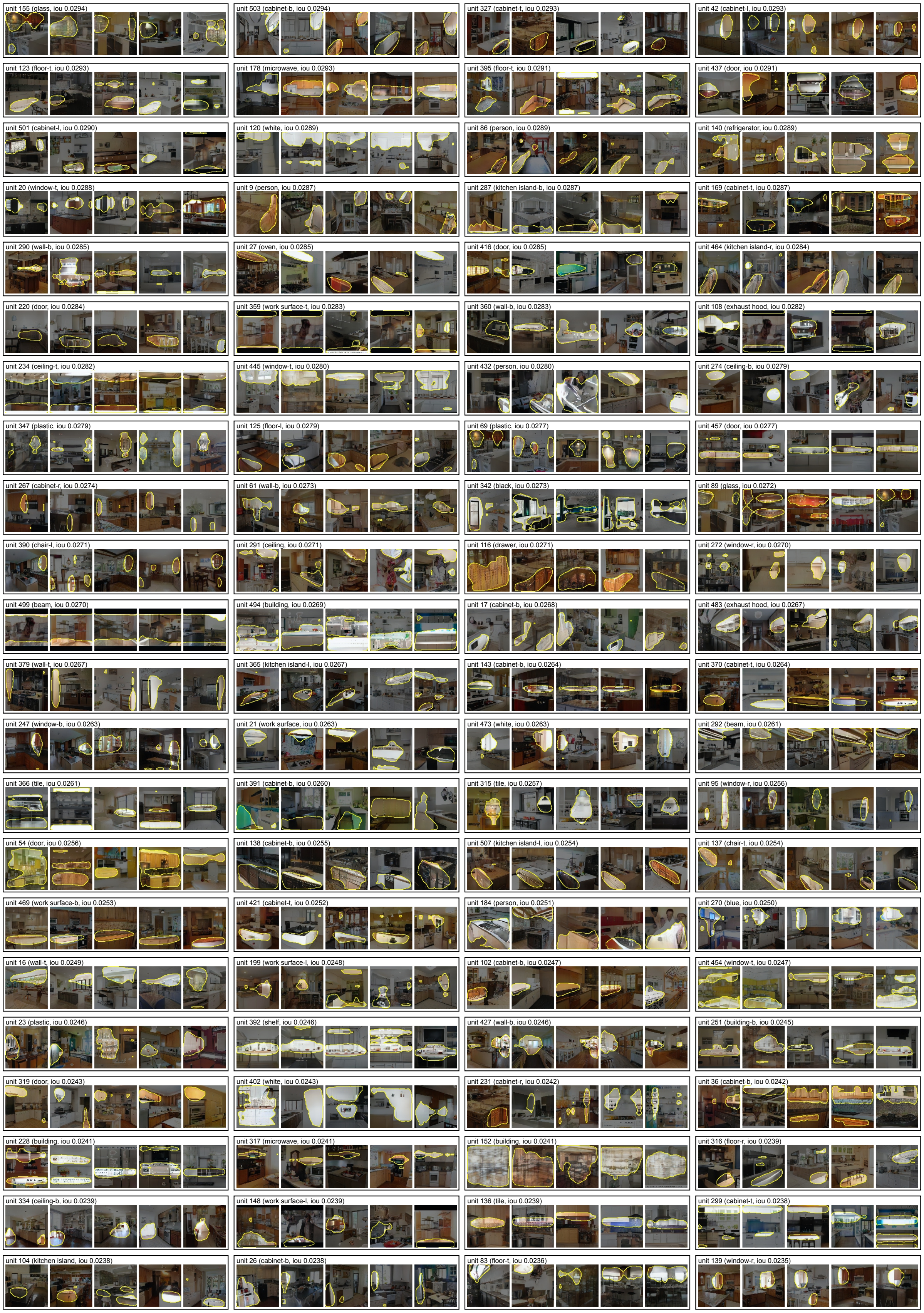
unit 155 (glass, iou 0.0294)
unit 503 (cabinet-b, iou 0.0294)
unit 327 (cabinet-t, iou 0.0293)
unit 42 (cabinet-l, iou 0.0293)
unit 123 (floor-t, iou 0.0293)
unit 178 (microwave, iou 0.0293)
unit 395 (floor-t, iou 0.0291)
unit 437 (door, iou 0.0291)
unit 501 (cabinet-l, iou 0.0290)
unit 120 (white, iou 0.0289)
unit 86 (person, iou 0.0289)
unit 140 (refrigerator, iou 0.0289)
unit 20 (window-t, iou 0.0288)
unit 9 (person, iou 0.0287)
unit 287 (kitchen island-b, iou 0.0287)
unit 169 (cabinet-t, iou 0.0287)
unit 290 (wall-b, iou 0.0285)
unit 27 (oven, iou 0.0285)
unit 416 (door, iou 0.0285)
unit 464 (kitchen island-r, iou 0.0284)
unit 220 (door, iou 0.0284)
unit 359 (work surface-t, iou 0.0283)
unit 360 (wall-b, iou 0.0283)
unit 108 (exhaust hood, iou 0.0282)
unit 234 (ceiling-t, iou 0.0282)
unit 445 (window-t, iou 0.0280)
unit 432 (person, iou 0.0280)
unit 274 (ceiling-b, iou 0.0279)
unit 347 (plastic, iou 0.0279)
unit 125 (floor-l, iou 0.0279)
unit 69 (plastic, iou 0.0277)
unit 457 (door, iou 0.0277)
unit 267 (cabinet-r, iou 0.0274)
unit 61 (wall-b, iou 0.0273)
unit 342 (black, iou 0.0273)
unit 89 (glass, iou 0.0272)
unit 390 (chair-l, iou 0.0271)
unit 291 (ceiling, iou 0.0271)
unit 116 (drawer, iou 0.0271)
unit 272 (window-r, iou 0.0270)
unit 499 (beam, iou 0.0270)
unit 494 (building, iou 0.0269)
unit 17 (cabinet-b, iou 0.0268)
unit 483 (exhaust hood, iou 0.0267)
unit 379 (wall-t, iou 0.0267)
unit 365 (kitchen island-l, iou 0.0267)
unit 143 (cabinet-b, iou 0.0264)
unit 370 (cabinet-t, iou 0.0264)
unit 247 (window-b, iou 0.0263)
unit 21 (work surface, iou 0.0263)
unit 473 (white, iou 0.0263)
unit 292 (beam, iou 0.0261)
unit 366 (tile, iou 0.0261)
unit 391 (cabinet-b, iou 0.0260)
unit 315 (tile, iou 0.0257)
unit 95 (window-r, iou 0.0256)
unit 54 (door, iou 0.0256)
unit 138 (cabinet-b, iou 0.0255)
unit 507 (kitchen island-l, iou 0.0254)
unit 137 (chair-t, iou 0.0254)
unit 469 (work surface-b, iou 0.0253)
unit 421 (cabinet-t, iou 0.0252)
unit 184 (person, iou 0.0251)
unit 270 (blue, iou 0.0250)
unit 16 (wall-t, iou 0.0249)
unit 199 (work surface-l, iou 0.0248)
unit 102 (cabinet-b, iou 0.0247)
unit 454 (window-t, iou 0.0247)
unit 23 (plastic, iou 0.0246)
unit 392 (shelf, iou 0.0246)
unit 427 (wall-b, iou 0.0246)
unit 251 (building-b, iou 0.0245)
unit 319 (door, iou 0.0243)
unit 402 (white, iou 0.0243)
unit 231 (cabinet-r, iou 0.0242)
unit 36 (cabinet-b, iou 0.0242)
unit 228 (building, iou 0.0241)
unit 317 (microwave, iou 0.0241)
unit 152 (building, iou 0.0241)
unit 316 (floor-r, iou 0.0239)
unit 334 (ceiling-b, iou 0.0239)
unit 148 (work surface-l, iou 0.0239)
unit 136 (tile, iou 0.0239)
unit 299 (cabinet-t, iou 0.0238)
unit 104 (kitchen island, iou 0.0238)
unit 26 (cabinet-b, iou 0.0238)
unit 83 (floor-t, iou 0.0236)
unit 139 (window-r, iou 0.0235)

Fig. S17. Comparing all units of `layer5` of Progressive GAN kitchen model, 5 of 6.

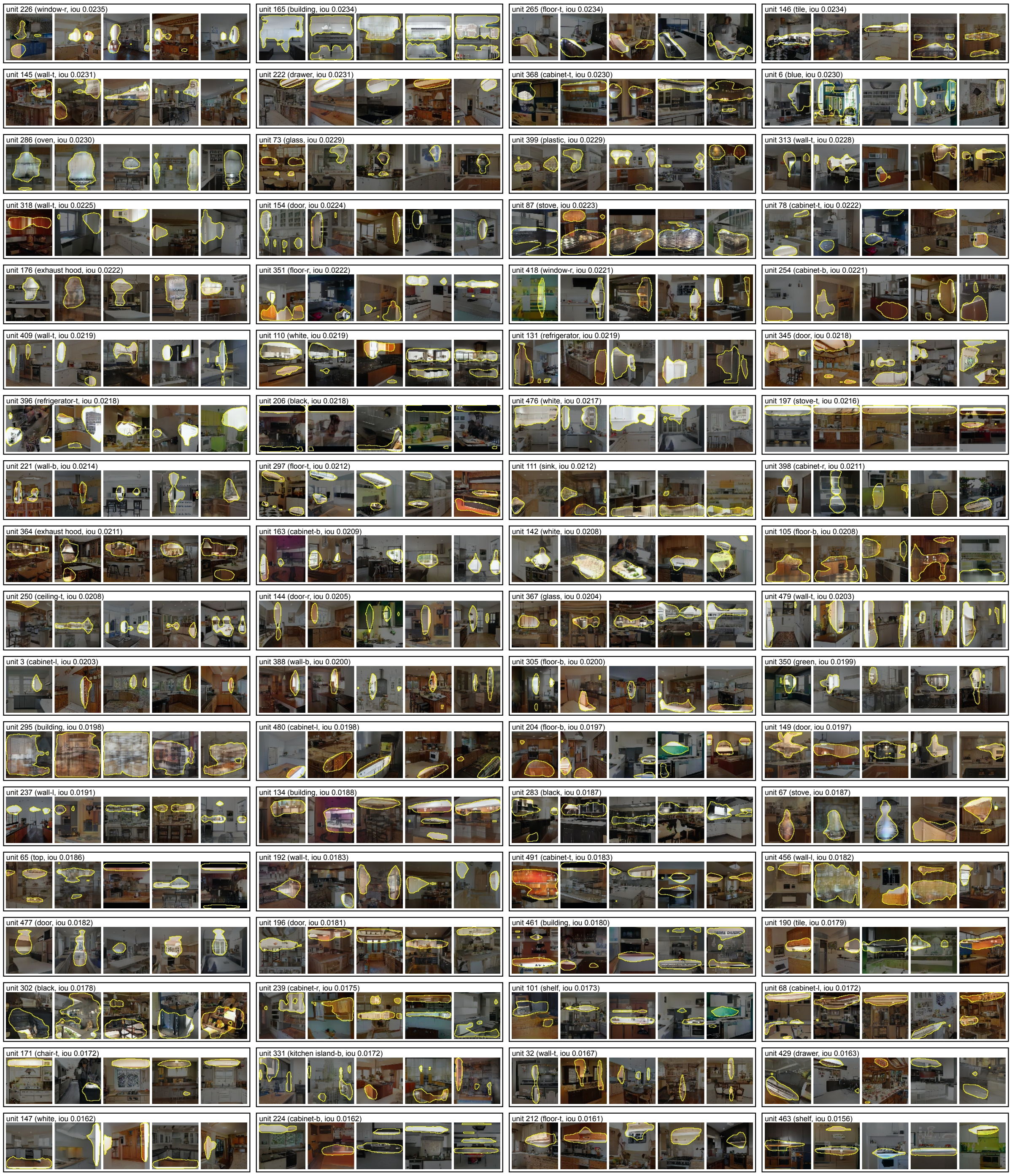
unit 226 (window-r, iou 0.0235)
unit 165 (building, iou 0.0234)
unit 265 (floor-t, iou 0.0234)
unit 146 (tile, iou 0.0234)
unit 145 (wall-t, iou 0.0231)
unit 222 (drawer, iou 0.0231)
unit 368 (cabinet-t, iou 0.0230)
unit 6 (blue, iou 0.0230)
unit 286 (oven, iou 0.0230)
unit 73 (glass, iou 0.0229)
unit 399 (plastic, iou 0.0229)
unit 313 (wall-t, iou 0.0228)
unit 318 (wall-t, iou 0.0225)
unit 154 (door, iou 0.0224)
unit 87 (stove, iou 0.0223)
unit 78 (cabinet-t, iou 0.0222)
unit 176 (exhaust hood, iou 0.0222)
unit 351 (floor-r, iou 0.0222)
unit 418 (window-r, iou 0.0221)
unit 254 (cabinet-b, iou 0.0221)
unit 409 (wall-t, iou 0.0219)
unit 110 (white, iou 0.0219)
unit 131 (refrigerator, iou 0.0219)
unit 345 (door, iou 0.0218)
unit 396 (refrigerator-t, iou 0.0218)
unit 206 (black, iou 0.0218)
unit 476 (white, iou 0.0217)
unit 197 (stove-t, iou 0.0216)
unit 221 (wall-b, iou 0.0214)
unit 297 (floor-t, iou 0.0212)
unit 111 (sink, iou 0.0212)
unit 398 (cabinet-r, iou 0.0211)
unit 364 (exhaust hood, iou 0.0211)
unit 163 (cabinet-b, iou 0.0209)
unit 142 (white, iou 0.0208)
unit 105 (floor-b, iou 0.0208)
unit 250 (ceiling-t, iou 0.0208)
unit 144 (door-r, iou 0.0205)
unit 367 (glass, iou 0.0204)
unit 479 (wall-t, iou 0.0203)
unit 3 (cabinet-l, iou 0.0203)
unit 388 (wall-b, iou 0.0200)
unit 305 (floor-b, iou 0.0200)
unit 350 (green, iou 0.0199)
unit 295 (building, iou 0.0198)
unit 480 (cabinet-l, iou 0.0198)
unit 204 (floor-b, iou 0.0197)
unit 149 (door, iou 0.0197)
unit 237 (wall-l, iou 0.0191)
unit 134 (building, iou 0.0188)
unit 283 (black, iou 0.0187)
unit 67 (stove, iou 0.0187)
unit 65 (top, iou 0.0186)
unit 192 (wall-t, iou 0.0183)
unit 491 (cabinet-t, iou 0.0183)
unit 456 (wall-l, iou 0.0182)
unit 477 (door, iou 0.0182)
unit 196 (door, iou 0.0181)
unit 461 (building, iou 0.0180)
unit 190 (tile, iou 0.0179)
unit 302 (black, iou 0.0178)
unit 239 (cabinet-r, iou 0.0175)
unit 101 (shelf, iou 0.0173)
unit 68 (cabinet-l, iou 0.0172)
unit 171 (chair-t, iou 0.0172)
unit 331 (kitchen island-b, iou 0.0172)
unit 32 (wall-t, iou 0.0167)
unit 429 (drawer, iou 0.0163)
unit 147 (white, iou 0.0162)
unit 224 (cabinet-b, iou 0.0162)
unit 212 (floor-t, iou 0.0161)
unit 463 (shelf, iou 0.0156)

Fig. S18. Comparing all units of `layer5` of Progressive GAN kitchen model, 6 of 6.

Movie S1. Shows the use of an interactive tool to deactivate tree units in a Progressive GAN while leaving the other units unchanged. When tree units are zeroed, trees are erased from the generated scene, revealing details of buildings that were previously occluded by the trees. The ability of the model to render details that are not drawn by default strongly suggests that the GAN has a high-level model of buildings that can be occluded by trees, not just memorized pixel patterns for scenes.

Movie S2. Shows the use of an interactive tool to activate door units of a Progressive GAN at different locations. Activating door units in different locations produces results that depend on the context. Doors can be added in contexts where a door would be reasonable, in appropriate locations of a building, but they are difficult to add in locations that would not make sense, such as in the sky or in a tree.

Movie S3. Demonstrates activating and deactivating a variety of GAN units in combination to paint semantic concepts on an image for artistic effect.